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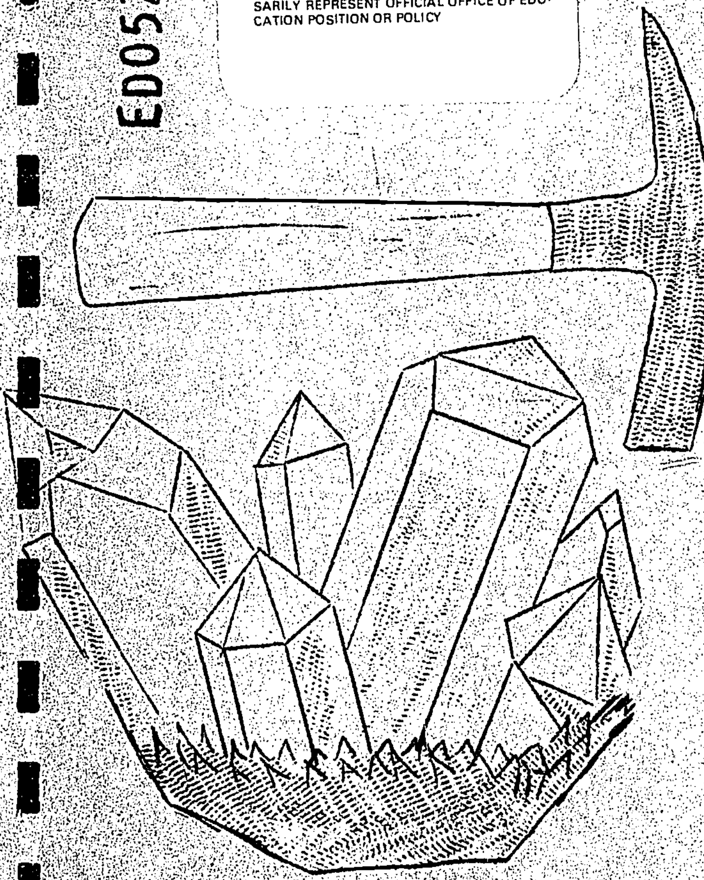
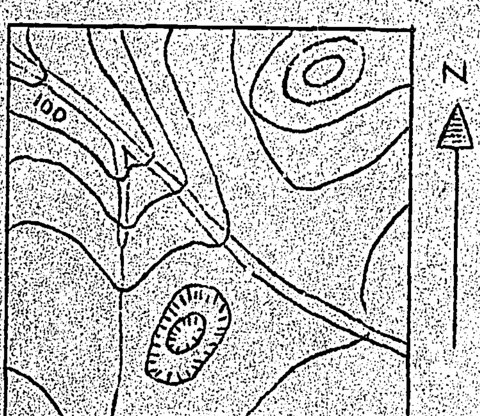
ABSTRACT

Included are instructional materials designed for use with disadvantaged students who have a limited reading ability and poor command of English. The guide is the second volume of a two volume, one year program in earth science, and contains these five units and activities: Rock Cycle, 12 activities; Minerals and Crystals, 6 activities; Weathering and Erosion, 4 activities; Earth and Space, 16 activities; and Oceanography, 8 activities. A formal textbook is not used in this program, and the learning process relies on class discussion supported by audiovisual materials and small group laboratory activities. Each lesson has a suggested format for teachers to follow in directing activities, with suggested teacher comments. Following each teacher section is the printed material for student use, which generally includes a list of required equipment for small group activities, introduction and procedures, and fill-in questions relating to the completed activity. (PR)



DISCUS NINTH GRADE EARTH SCIENCE



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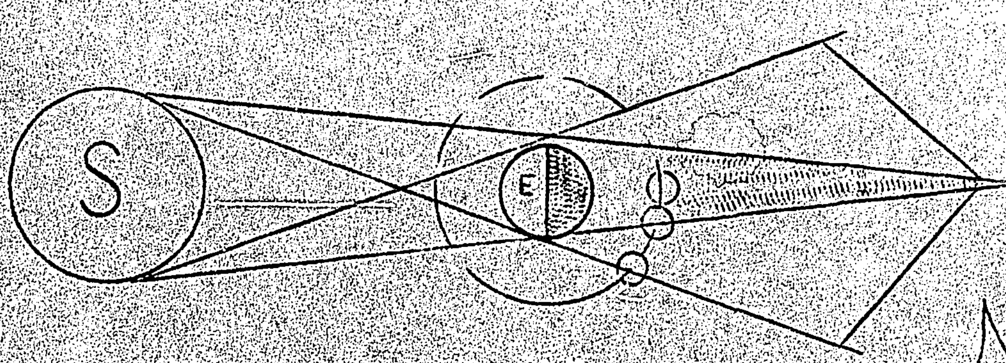

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The DISCUS project has developed a course of study in science for the junior high grades (7-9). The material for each grade level has been bound into two manuals.

GRADE 7	BIOLOGICAL SCIENCE
GRADE 8	PHYSICAL SCIENCE
GRADE 9	EARTH SCIENCE

Your comments concerning these materials will be appreciated. For further information, contact the project director.

Revised
1-23-70

Second Semester

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* Reading Activities

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E-39	FOSSILS ARE INTERESTING
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BOOKS:

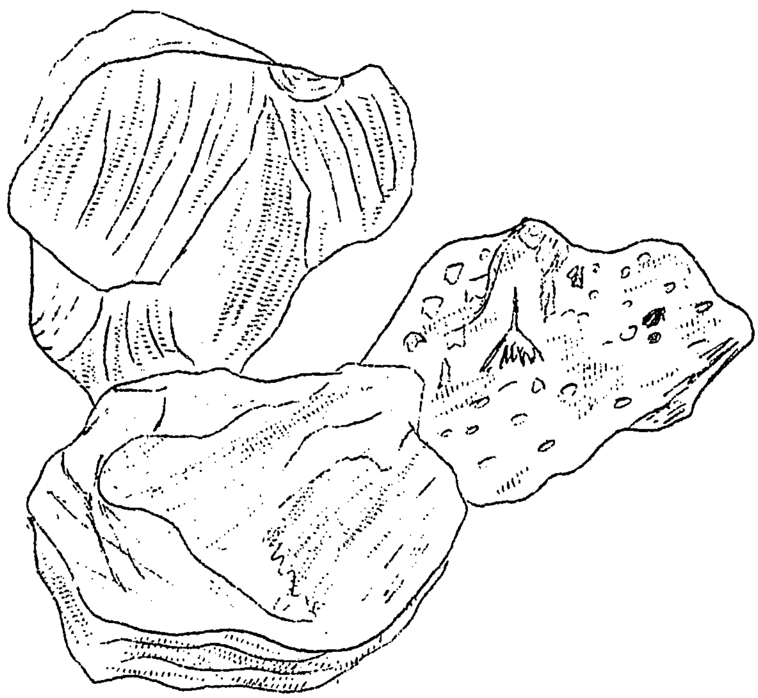
Geology and Earthscience Source Book, Holt, Rinehart and Winston, Inc. 1962 page 14 and 15

Earth Science Curriculum Project (ESCP), Investigating the Earth, Houghton, Mifflin Co., 1967, pages 330 - 346.

Physical Geology Prentice-Hall, 1967

Modern Earth Science, Holt, Rinehart and Winston, 1965

UNIT 5
THE ROCK CYCLE



UNIT 5

ROCK CYCLE

Rocks are large masses of material that make up the earth's crust. Some do not have discrete minerals but are composed of glasses or of organic materials like coal. Many rocks are not -- as soil, gravel, sand and clay. Most rocks contain several minerals or were formed from older rocks in which these minerals were present.

In this unit we will see how the combination of minerals, soils, gravel, etc. goes through different changes and help explain our rock cycle.

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E-31	ROCKS AND MINERALS - Film: ROCKS AND MINERALS
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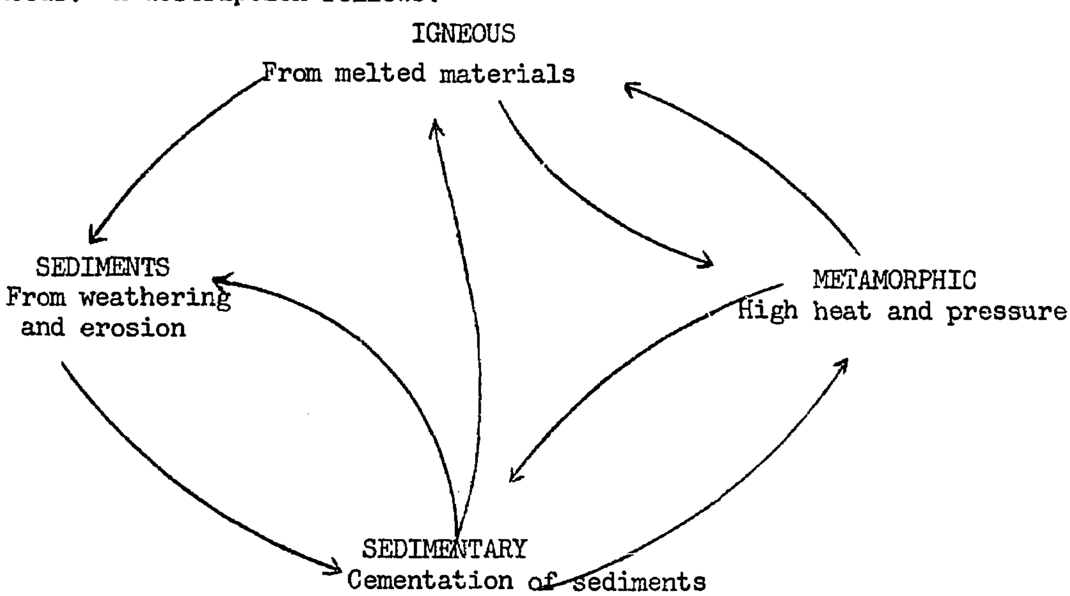
* Reading Activity

UNIT 5 ROCK CYCLE

Rocks can be classified in several ways, two of which are fairly common and quite acceptable. An exact classification can be based on chemical analysis, but this method is complicated and requires expensive apparatus. Another method which does not require much apparatus is to classify the rocks according to their origin. This is called the genetic classification and is based on the formation of the rock as based on appearance — physical features such as layering grain size and shape, cementing qualities, color, streak, etc.

The rock cycle is a means of representing interrelationships of rocks using the genetic classification. The three classes of rocks are sedimentary, metamorphic, and igneous. A description follows.



1. Igneous rocks are formed by the cooling and hardening of hot, molten material. Lava pouring from a volcano and solidifying into rock is an example. The rocks may form below or on the earth's surface.
2. Metamorphic rocks are formed from igneous, sedimentary, or other metamorphic rocks that have been heated and/or pressed together under high pressure. These rocks are usually formed deep under the surface of the earth, and are found at the surface after extensive erosion.

3. Sedimentary rocks, are formed by the physical and chemical breakdown of igneous, metamorphic and other sedimentary rocks.

Weathering causes the physical and chemical breakdown when the rocks are exposed to the hydrosphere and the atmosphere. Chemical weathering occurs when some components of a rock combine with oxygen, carbon dioxide, water, or with other chemicals in the air or water. In this way some of the minerals form new compounds and when iron rusts it combines with water and oxygen thus making a product which occupies more space then the original iron thus causing the rusty surface to pull away from the original iron. Physical weathering occurs when there is a change in temperature, with some minerals expanding faster than others; or when water contained in the pores of the rock freezes, expands and breaks that rock. Sometimes plants roots grow in crevices, splitting the rock apart. Rocks may be ground up by abrasive action as is moved over the surface of the earth. Particles of rock are further worn as the fragments are transported by streams, ice and wind. These fragments then may accumulate as sediments which become cemented and compacted together to form sedimentary rocks.

The rock cycle provides a means of expressing the many earth processes which are involved in rock formation. The transporting agents, they physical influences of heat and pressure, and chemical action are the important factors in rock formation. The chemical composition is important in the identification of specific rocks, but in the broad general processes of the rock cycle the identification of specific chemical compounds being present or not being present, is not as meaningful as the physical processes. In other words, igneous rocks will

form from melted materials regardless of the chemical content of the melted material; metamorphic rocks result from heat and/or pressure, and chemical reaction; and sedimentary rocks are the product of weathered and deposited sediments that have accumulated and have been cemented.

A mineral is a solid element or compound with distinctive chemical and physical properties or characteristics by which it can be readily identified. Most minerals are recognized by their physical properties such as color, shape, and hardness, but others are identified only by means of chemical analysis, microscopic, or x-ray methods. Mineral identification keys are available for making specific identifications. A typical key can be found in the American Geological Institute publication, GEOLOGY AND EARTH SCIENCES SOURCEBOOK, Holt, Rinehart, and Winston, Inc. 1962, pages 14 and 15. Over 2,000 minerals have been identified, thus trying to memorize the names of the minerals seems impossible as well as unnecessary, since the keys make identification easy. However, the common rocks are composed chiefly of a relatively small number of minerals.

To use a key, a compilation of the following properties are essential:

1. Color of an untarnished surface.
2. Streak color--this may or may not be identical to the mineral color.
3. Luster, or the "shine" or the way light if reflected such as brilliant like a diamond, glassy like glass, greasy, waxy, silky, or dull.
4. Cleavage or planes of breakage when under stress.
5. Hardness
6. Weight

The use of keys for identification purposes is not included in the activities. If the students wish to study mineral identification, the GEOLOGY AND EARTH SCIENCE SOURCEBOOK has many well written activities.

This unit will emphasize changes as they are related to the rock cycle. Most of the technical terms will be omitted. The relationship of the water cycle, heat, weathering, erosion and deposition to the rock cycle is considered essential to form a model reflecting a broad generalized scheme needed for understanding earth processes.

TOPIC 1 - Minerals that have the same appearance and chemical composition have the same hardness, the same streak, and the same color. Different minerals have different appearances and chemical composition and will probably exhibit different hardnesses, different streaks, and different colors.

Minerals are identifiable by their physical appearances, properties, and chemical compositions. The appearance of a mineral reflects the environment in which it was formed. The well formed crystals of minerals have a regular geometric shape with smooth faces. If the minerals form under crowded conditions, the crystal faces may not have regular geometric shapes. To illustrate some physical properties of minerals, the first nine minerals in the Mohs' Hardness Scale and Staurolite, hardness 7; Cinnabar, hardness 3; and Chalcopyrite, hardness 3.5; show hardness and streak color. The Mohs' Hardness Scale and the streak on a porcelain plate is:

1. Talc - - - White Streak
2. Gypsum - - White Streak
3. Calcite -- White Streak
4. Fluorite - White Streak
5. Apatite -- White Streak
6. Orthoclase - White Streak
7. Quartz - - - None
8. Topaz - - - None
9. Corundum - - None
10. Diamond - - None

TEACHER DIRECTION E - 29

MINERAL CRYSTALS, HARDNESS, AND STREAK COLOR

Materials for groups of three:

1. Staurolite
2. Chalcopyrite
3. Cinnabar
4. Porcelain Plate
5. Penny
6. Talc
7. Gypsum
8. Calcite
9. Fluorite
10. Apatite
11. Orthoclase
12. Quartz
13. Topaz
14. Corundum

The purpose of this activity is to demonstrate Mohs' Hardness Scale, the streak test, and the regular geometric shape of crystals.

The students are to establish the Hardness Scale. Initiate the activity by demonstrating that quartz will scratch glass, using a piece of glass, but fluorite will not. The streak test can be demonstrated using a Porcelain plate and cinnabar. Explain that a fresh, clean surface of the mineral must be used.

A SCIENTIST NAMED MOHS' DEVELOPED A HARDNESS SCALE. HE USED TEN MINERALS. YOU WILL BE GIVEN NINE OF THE TEN HE IDENTIFIED AS ONE THROUGH TEN. Demonstrate hardness by using quartz and fluorite. YOU ARE TO PUT THESE INTO THE ORDER HE USED. NEXT, YOU WILL RECEIVE THREE MINERALS. YOU ARE TO DETERMINE THEIR HARDNESS. REMEMBER, USE A FRESH, BRIGHT SURFACE OF THE MINERAL FOR TESTING. Discussion.

Demonstrate the streak test using cinnabar. Caution the students not to confuse the streaks with scratches. A streak is a powder trail, a scratch leaves a trench.

Teacher Direction
page 2

Pass out E-29

Label a demonstration set of minerals for the students to use in identifying their minerals. If the student's minerals are not labeled, pass out scotch tape or glue for the students to label the minerals themselves.

Upon completion, discuss the results, explain that streak tests and hardness tests are not always conclusive in identifying minerals. They are only clues. The crystals of staurolite, chalcopyrite, and cinnabar may be of interest. Discuss their relationship to their environment when forming.

STUDENT E - 29

MINERAL CRYSTALS, HARDNESS, AND STREAK COLOR

Minerals for groups of three:

1. Staurolite
2. Chalcopyrite
3. Cinnabar
4. Porcelain Plate
5. Minerals of Mohs' Hardness Scale:
   a. Talc
   b. Gypsum
   c. Calcite
   d. Fluorite
   e. Orthoclase
   f. Apatite
   g. Quartz
   h. Topaz
   i. Corundum

Minerals are formed in many different ways and under many different conditions. They may be formed from a hot, molten liquid (igneous) such as lava from a volcano; or they may be formed due to the heat and pressure found deep in the earth without ever melting and flowing (metamorphic). The sizes of the crystals may vary also. Crystals must have space and time to grow. If there is not enough space, they will be small or irregularly shaped.

Minerals have characteristics that remain the same, whether small crystals or large crystals are formed. Whether they are perfectly shaped or irregularly shaped. Two of these characteristics are hardness and streak color. The hardness is a mineral's resistance to being scratched. A hard mineral cannot be scratched by a softer mineral, but a hard mineral will scratch a softer mineral. The streak of a mineral is the color of its powder, and for many minerals it is not the same as the color of the mineral.

Your instructor will give you nine minerals. Place the minerals in numerical order from one to nine according to hardness. The mineral assigned number one is to be the softest, and number nine will be the hardest.

Student
page 2

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

After arranging the nine minerals according to hardness, find out the hardness and streak color of staurolite, chalcopyrite, and cinnabar.

1. What is the color of the streaks of the nine minerals in the Mohs' Hardness Scale. If you cannot tell, write "cannot tell".

	MINERALS NAME	STREAK COLOR	HARDNESS
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			

2. What is the hardness of Staurolite? What is the color of its streak?

3. What is the hardness of Chalcopyrite? What is the color of its streak?

4. What is the hardness of Cinnabar? What is the color of its streak?

5. Does the hardness give any clue as to what color the streak is? Give four examples.

Student
page 3

6. Does the color of the mineral give you any clue as to what color the streak is? Give four examples.

TEACHER DIRECTION E - 30

IDENTIFYING MINERALS BY SPECIFIC GRAVITY

Materials for groups of three:

1. Spring balance
2. Beaker (400 ml)
3. A piece of Chalcopyrite
4. String 5"
5. Flourite
6. Feldspar (microcline
7. Staurolite

The purpose of this activity is to show that specific gravity is another characteristic that may aid in mineral identification. What we would like to develop in the students is specific gravity is a ratio of the weight of an object to the weight of an equal volume of water.

Before the students begin work ask them, HOW CAN A PIECE OF CHALCOPYRITE WEIGH DIFFERENT AMOUNTS AT DIFFERENT TIMES IF IT IS NOT CHANGED IN ANY WAY? Allow them to give their ideas about this problem, but do not give the answer.

Have the students to read the directions silently while you read them aloud. Answer any questions the students might have concerning the procedure. Let them begin.

After the students have weighed the chalcopyrite out of the water and then ask them, DOES THE CHALCOPYRITE WEIGH MORE OR LESS WHEN IT IS IN THE WATER? Less. WHY? The chalcopyrite is held up by a force equal to the water it displaced.

Move about the students assisting if necessary. After the children understand how to find the specific gravity of chalcopyrite allow them to determine the specific gravity of fluorite, feldspar and staurolite.

Teacher Direction
page 2

Below are the specific gravity of some common minerals. Some will vary because of the impurities.

Sulfur	2.0	Hornblende	3.1
Halite (salt)	2.1	Fluorite	3.2
Feldspar	2.5	Topaz	3.5
Quartz	2.7	Staurolite	3.7
Calcite	2.7	Corundum	4.0
Talc	2.8	Chalcopyrite	4.3

STUDENT E - 30

IDENTIFYING MINERALS BY SPECIFIC GRAVITY

Materials for groups of three:

1. Spring Balance
2. Beaker (400 ml)
3. 4 piece of chalcopyrite
4. String 5"
5. Fluorite
6. Feldspar (microcline)
7. Staurolite

In the previous activity you found you could identify some minerals by their hardness and streak, in this activity you will learn how to identify minerals by their specific gravity. Obtain the materials from your teacher. Then weigh a piece of chalcopyrite on your spring balance (with the string attached to it) and record its weight. Now weigh the chalcopyrite while it is in a beaker of water and record its weight again. (Still suspended from the string) now subtract the weight of the chalcopyrite in water from the weight of the chalcopyrite in air. This will give the loss of weight in water. Then divide the weight in air by the loss of weight in water. This ratio is the specific gravity of chalcopyrite. Below is an example of the method used.

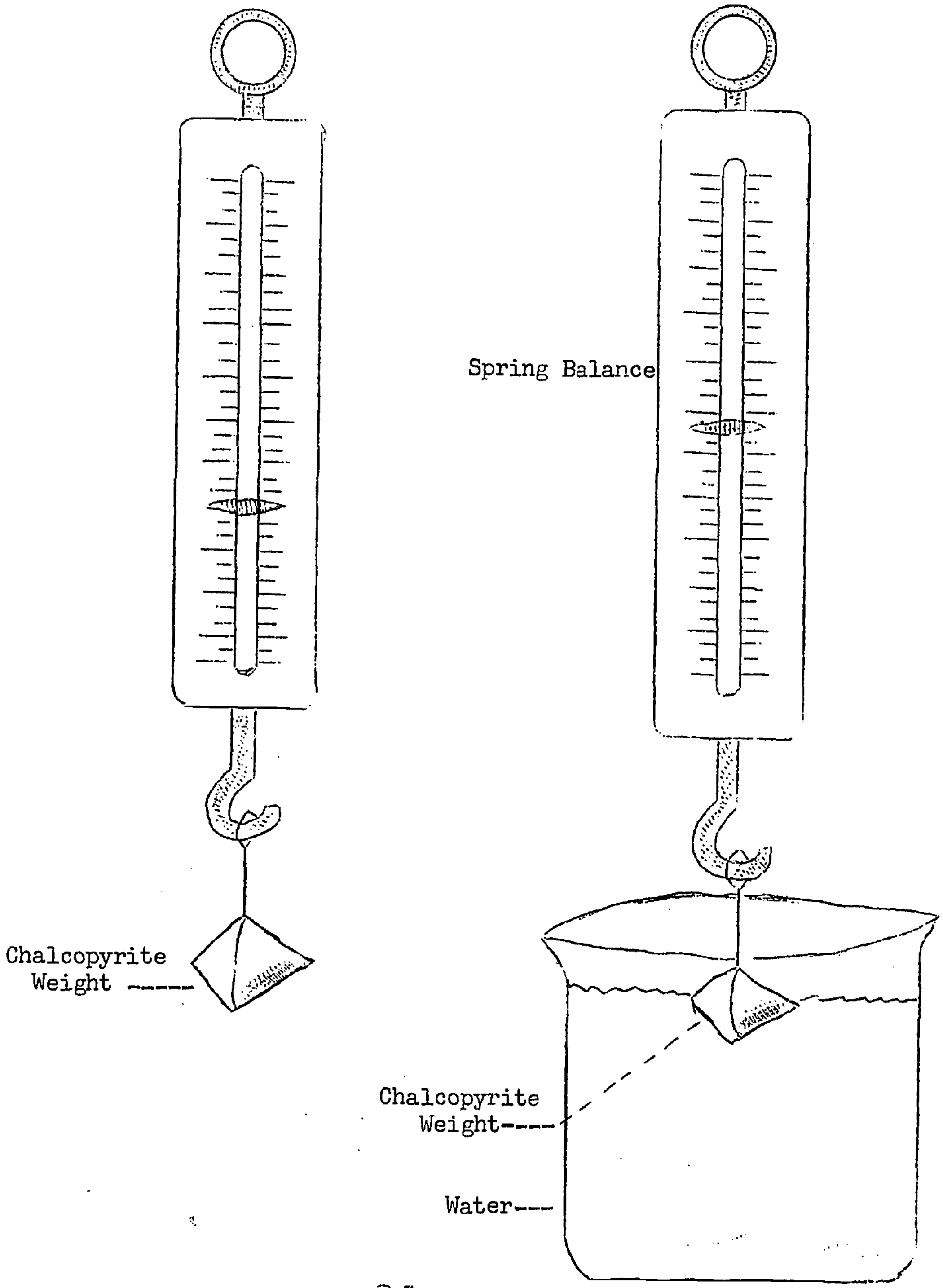
Weight of Chalcopyrite in air	=	50.0 grams
Weight of Chalcopyrite in water	=	31.5 grams
Weight loss in water	=	18.5 grams

$$\text{Specific gravity} = \frac{\text{Weight of Chalcopyrite in air}}{\text{Weight loss in water}}$$

$$= \frac{50.0 \text{ grams}}{18.5 \text{ grams}}$$

$$= 2.7$$

Student
page 2



TOPIC 2 - A mineral is a solid element or a compound occurring in nature and having a definite composition and appearance.

TEACHER DIRECTION E - 31

ROCKS AND MINERALS

Materials for groups of three:

1. Limestone
2. Marble
3. Hand Lenses
4. Dilute Hydrochloric acid
5. Hammer
6. Mica Schist

Over 2,000 minerals have been identified. Minerals are naturally-occurring substances found in rocks. Minerals give clues of the environment in which they are formed. Three rocks are used in this activity; limestone, which is a sedimentary rock formed in the ocean; and two metamorphic rocks, marble and mica schist. The marble and the limestone have essentially the same composition, and are chiefly composed of the mineral calcite. In the limestone, however, the calcite is in the form of shells and small fragments, while in the marble it has crystallized. Thus, the marble is considered a metamorphosed limestone, a limestone that has been changed by heat and pressure, so these two rocks illustrate two stages in the rock cycle, namely a sedimentary rock and a sedimentary rock that has been changed into a metamorphic rock.

The purpose of this activity is to initiate a list of characteristics of sedimentary rocks and metamorphic rocks.

Ask the students to group themselves into groups of three. To each group give one piece of limestone, one piece of mica schist, and a hammer. Ask the groups to sit in a circle and the instructor can stand in the middle. As the students ask questions and make contributions, ask them to show you. This will aid in communication.

Teacher Direction
page 2

Instruct each group to take out two sheets of paper and write sedimentary on one piece and metamorphic on the other. You will have to spell the words. The students are to make a list from the discussion. Ask the students to write on the appropriate piece of paper labeled "metamorphic" and "sedimentary".

TAKE OUT TWO SHEETS OF PAPER FOR EACH GROUP. Pause, giving time to obtain the paper. If students do not have paper, give them some. ON ONE SHEET, WRITE SEDIMENTARY. Spell the word. ON THE SECOND SHEET, WRITE METAMORPHIC. Spell the word. LET'S TRY TO MAKE A LIST OF CHARACTERISTICS OF EACH ROCK. DO NOT WRITE ANYTHING UNTIL WE ALL DECIDE WHAT SHOULD BE WRITTEN. BREAK THE ROCK TO EXPOSE A FRESH SURFACE. Attempt to obtain group discussion. Interject suggestions and the terms sedimentary and metamorphic at every opportunity. Fossils in the limestone are examples of past life as well as a characteristic of sedimentary rocks. The absence of fossils in the schist is characteristic of metamorphic rocks. Metamorphic rocks rarely contain fossils, but this fact need not be brought up at this time. The banding of metamorphic rocks is indicative of pressure. The crystallized mica is the result of heat and pressure. Metamorphic rocks show more compaction and cementation. When metamorphic rocks are broken, they break across the mineral crystals. For example, mica schist splits easily across the mica crystals; on the other hand, sedimentary rocks break around the minerals, grains, fragments, chunks, etc. A hand lens may be required to note these differences.

Pass out E-30

Teacher Direction
page 3

Upon completion of the activity assemble for a class discussion. Discuss the findings recorded in the table, using a prepared acetate. Stress the difference in the appearances of the three rocks.

Discuss the reason for exposing a fresh surface on the rocks. The outer surfaces of the minerals may have weathered.

STUDENT

E - 31

ROCKS AND MINERALS

Materials for groups of three:

1. Limestone
2. Marble
3. Diluted Hydrochloric acid
4. Hand lenses
5. Mica Schist
6. Hammer

What is a rock? What is a mineral? Well, a rock is an aggregate of minerals, but it may be just one mineral. Let's define minerals by saying that a mineral is a naturally occurring material having a definite appearance and a definite chemical composition.

You see, rocks are formed in many ways. The materials on the bottom of the ocean maybe buried and tightly packed, together thus forming a rock. This rock might contain a number of different-looking parts--minerals.

You have a piece of limestone and a piece of marble. Let's see how they are alike or different. They are alike in that they were once part of a bottom of the ocean. They are different because of what happened to them after they were formed.

Let's test limestone, schist, and marble at the same time and compare the results. Place the limestone on a piece of paper numbered 1; the marble on another piece of paper marked 2; and the mica schist on a piece of paper marked 3.

First, add 1 drop of diluted hydrochloric acid to each rock. Limestone and marble will bubble where the acid is placed, but the schist will not. With the hammer break the rocks and use the bright, clean side for observation.

Student
page 2

LIMESTONE	MARBLE	MICA SCHIST
1. Drawing	1. Drawing	1. Drawing
2. Are any fossils present	2. Are any fossils present	2. Are any fossils present
3. Number of different kinds of minerals	3. Number of different kinds of minerals	3. Number of different kinds of minerals
4. Can you see layers:	4. Can you see layers?	4. Can you see layers or bands?
5. List the colors	5. List the colors	5. List the colors

TEACHER DIRECTION E - 32

A CLOSE LOOK AT SEDIMENTARY AND METAMORPHIC ROCKS

Materials for groups of three:

1. Limestone
2. Marble
3. Garnet mica schist
4. Hammer
5. Hand Lenses

The students are to grind up and separate each rock into groups of minerals. A mineral is a naturally-occurring material with a definite appearance and a definite chemical composition.

The students will need help in describing their findings. Suggest key words regarding color, feel, angles, length, width, etc., when needed.

Holding samples of the two rocks, lead the discussion. HOW MANY DIFFERENT KINDS OF SUBSTANCES ARE IN THE LIMESTONE? Hold up the limestone for demonstration. HOW MANY KINDS OF SUBSTANCES ARE IN THE MARBLE? Hold up the marble for demonstration. DO YOU KNOW WHAT SCIENTISTS CALL THE PARTS OF ROCKS THAT LOOK EXACTLY ALIKE? Pause. THEY CALL THEM MINERALS. THESE MINERALS YOU SEE IN THESE TWO ROCKS HAVE THE SAME COMPOSITION AS WELL AS LOOK ALIKE, THEREFORE, THE LIMESTONE AND MARBLE ARE MADE OF THE SAME MINERALS. HOW MANY MINERALS ARE IN THE SCHIST? Discussion. Stress the relationship of mineral to the total rock.

Pass out E-32

Upon completion of the activity, reassemble for a class discussion. Start the class discussion at least fifteen minutes before the end of the period. Ask the students to compare their findings in E-32 with those in E-31 and then make corrections and write a new list using a clear acetate and help compile a list of characteristics. Ask the students to copy this list for future reference.

Teacher Direction
page 2

Ask the students to explain how a metamorphic rock could become a sedimentary rock. Do not use the terms erosion and weathering, but water, wind, and chemical action.

Ask the students to explain how a sedimentary rock could be buried very deep where heat and pressure caused it to change to marble, a metamorphic rock. A good demonstration to show that they are chemically alike is to place part of the ground-up limestone into a 500 ml solution of diluted hydrochloric acid, and some of the ground-up marble into another 500 ml of hydrochloric acid. Do not structure the discussion, rather, ask questions. Use the terms minerals, sedimentary, and metamorphic freely. Compliment their use, but do not require their use.

A CLOSE LOOK AT SEDIMENTARY AND METAMORPHIC ROCKS

Materials for groups of three:

1. Limestone
2. Marble
3. Garnet mica schist
4. Hammer
5. Hand lenses

In activity E-31 we saw that a different looking material was on the surface of each rock. All that could be seen was the outside. Let's see what is inside. Can you divide the materials inside the rock into separate piles of minerals? Minerals are the parts of a rock that look the same and have the same chemical composition.

On one sheet of paper, write "limestone", on the second sheet write "marble", and on the third sheet write schist.

With the help of your instructor, grind each rock up separately. Then, separate the minerals into piles. Keep the minerals from each rock on the same sheet of paper. Below each pile of minerals record the color, shape, how it feels, drawings of its appearance, plus any other important things you can see.

Compare your lists to the ones made in Activity E-31.

TOPIC 3 Metamorphic rocks formed from sedimentary rocks reflect the enviroment and composition of the parent rock. As temperature, pressure, and chemical composition change, the resulting metamorphic rock changes, reflecting the changing environment.

TEACHER RESOURCE

Three conditions are necessary to form metamorphic rocks:

1. The rock must not melt; it may become soft like a plastic but it always remains solid.
2. Heat and pressure are required. Under the influence of pressure, changes take place which reduce the size of the rock.
3. Chemical reactions occur, resulting in the formation of new minerals or the destruction of old minerals, or the changes in appearance and space relation of existing minerals.

Metamorphic rocks have changed in appearance and volume in the solid state in response to a pronounced alteration in temperature, pressure, and chemical environment. All of these are brought about by the same forces that cause folding, faulting, injection of molten lava (magma), and the elevation and depression of mountains. These forces bring about changes within the rocks. Metamorphism occurs within the earth's crust, below the zone of weathering and cementation and outside the zone of melting.

The chemical composition and the grain size of the parent rock are the major factors influencing the kinds of metamorphic rock that evolve. Hot water solutions released late in the solidification of magma often invade surrounding rocks. This introduces new chemicals into the surrounding rocks which can cause alterations in the rocks. These solutions from the magma usually remain in areas close to igneous formations.

Teacher Resource
page 2

The grain size of the rocks affect the rate that rocks can be changed. If new solutions are introduced, the fine-grained rocks are more readily changed than the larger-grained rocks because they have greater areas of grain surface exposed to the chemically active fluid.

Two different types of metamorphism occurs----Contact and regional----. Contact metamorphism occurs in restricted zones where molten rock comes in contact with cooler rocks. The hot gases, solutions, and heat from the molten rock cause chemical changes in the surrounding rocks. The extent of contact metamorphism is usually restricted---seldom measuring more than a few hundred feet in width.

Regional metamorphism may cover thousands of square miles and be thousands of feet thick. It occurs at great depth during mountain building. Rocks representing regional metamorphism which are shown in E-33, are gneiss, schist, slate, and marble. Staurolite and garnet are examples of minerals found in regional metamorphosed rocks.

TEACHER DIRECTION

E-33

SEDIMENTARY TO METAMORPHIC

This reading activity is to clinch that part of the rock cycle dealing with sedimentary and metamorphic rocks. New terms introduced are weathering and erosion. A short discussion of these two terms before passing out E-33 will be necessary. Other terms that need to be mentioned are higher temperature--hotter, increased pressure--more pressure, cycle-- a recurring process, and rafters(support) in a mine.

Pass out E-33

Instruct the students to read the activity quietly, then read it aloud, discussing the points of interest. Answer the question at the end of the activity. The answer is that metamorphic rocks, when exposed at the surface, may be weathered, eroded, and transported away, or buried again.

STUDENT E - 33

SEDIMENTARY TO METAMORPHIC

Rocks on and under the surface of the earth are always changing. The rocks on the surface are exposed to the hydrosphere and atmosphere. They break down and provide materials which become sediments. The breaking down of the rocks is called weathering. The weathered material is picked up by wind, water, or ice and carried to a new location. The movement of the weathered rocks, with the accompanying abrading, and pulverizing action is called erosion. The process is an age-old cycle of crumbling by weathering, grinding as the material is moved by erosion, and deposition of the transported materials as sediments to form a new rock.

Changes that occur in rocks deep below the earth's surface are very different from the changes caused by weathering. Weathering reduces the size of rocks and minerals whereas the processes that affect rock materials deep in the earth's surface commonly causes minerals to grow larger or form new ones. The changes are due to the higher temperatures and pressures on the earth's surface, but still are not high enough to cause the rocks to melt.

How do we know these things happen: Can we see minerals growing? No. We must look at the evidence available. Drillers of deep wells have shown time after time that the earth gets hotter as you drill deeper. Miners in deep mines have reported that rocks bulge out--bending large rafters (supports) due to pressure on the rocks. It is certain that pressure and temperature increase as you go downward into the earth.

After millions of years of weathering and erosion of the earth's surface, the deeply buried rocks may become exposed. We can then observe them and form ideas regarding their formation. The questions that many ask are: Can you show me?" "Can you demonstrate it in the laboratory?" "Can you make it?"

Student
page 2

No, we can't show a mineral growing for thousands of years. We can grow minerals in the laboratory, and we sure have some good evidence. Yes, we can make some of the crystals, in fact we can make some larger and more symmetric than nature . You will have an opportunity to make some crystals in the next unit.

If the metamorphic rocks are exposed to the hydrosphere and atmosphere, what will happen.

TEACHER DIRECTION E - 34

EVIDENCE OF SEDIMENTARY ROCKS BECOMING METAMORPHIC ROCKS

Materials for groups of three:

1. Clay (rock)
2. Shale
3. Slate
4. Schist
5. Gneiss

The five rocks are to be arranged according to the degree of metamorphism, that is, to the degree of increased temperature and pressure.

The arrangement should be:

1. Clay
2. Shale
3. Slate
4. Schist
5. Gneiss

The students will then be able to see representative samples of a clear change due to an increase in temperature and pressure.

Rocks become more dense as the rock environment becomes hotter and as squeezing becomes more intense. The minerals that make up the rock also change as the environment changes. Garnet, a very dense, symmetrical mineral with smooth faces can form where schist and gneiss form because the pressure and temperature requirements are the same for the formation of schist and garnet.

The activity should be initiated by a short review of Activity E-33, then read the student directions aloud. The students should be successful with a minimum of assistance.

Pass out E-34.

Upon completion, discuss the results. The last statement in the table regarding melting will lead into the next topic. Clinch the important principle that metamorphic rocks can never melt (become liquid). If they do melt, they will form igneous rocks.

STUDENT

E - 34

EVIDENCE OF SEDIMENTARY ROCKS BECOMING METAMORPHIC ROCKS

Materials for groups of three:

1. Clay
2. Shale
3. Slate
4. Gneiss
5. Schist

If someone handed you five rocks and aksed you for all the information you could provide about those rocks, you would first need to know where they came from and how they were obtained.

Let's assume that the person who brought the rocks had drilled a very deep hole into a mountain. The only things he could remember were:

1. One rock was a core sample taken out at $\frac{1}{4}$ mile deep.
2. The second was from a core 3 miles deep.
3. Another rock was found 10 miles below the surface.
4. Another was from a core 15 miles deep.
5. The last rock was taken from a core 19 miles deep.

The rocks are obviously similar, but something has happened. Layering will give a clue of increased pressure. Crystaline surfaces will be a clue to increased temperature.

Write the name of the rock next to the hypothetical depth and temperature in the table at which you think it would form:

NAME OF ROCK	TEMPERATURE	DEPTH
1.	180° F	$\frac{1}{4}$ mile
2.	360° F	3 miles
3.	720° F	10 miles
4.	900° F	15 miles
5.	$1,080^{\circ}$ F	19 miles
MELTING TAKES PLACE	$1,300^{\circ}$ F	? miles

Student
page 2

1. Which rocks are sedimentary? How do you know?

2. Which rocks are metamorphic? How do you know?

3. If the rock temperature reached 1,300° F, what would happen according to the table? Would it form a metamorphic rock at 1,300° F according to the table?

TEACHER DIRECTION E - 35

DIFFERENCES IN METAMORPHIC ROCKS

Materials for groups of three:

1. Hammer
2. Hand lens
3. Diopside
4. Tremolite
5. Sandstone
6. Quartzite
7. Metamorphosed conglomerate
8. Sedimentary conglomerate

Initiate the activity by showing four films:

1. MINERALS AND ROCKS, 11 minutes, Britannica
2. ROCKS, 14 minutes, Gateway Productions
3. VOLCANOES IN ACTION, 11 minutes, Britannica
4. WHAT'S INSIDE THE EARTH, 13 minutes, Film Association of California

The films will serve as a review as well as introduce E-35. After each film discuss the relationship of concepts presented in the film to the activities. These discussions are to reinforce ideas in previous activities, introduce E-35, and intitate a mental model of the rock cycle. Emphasize the importance of contact and regional metamorphism and what happens to particular rocks, especially clays, sandstones, shale. The film on volcanoes will provide some experience to discuss contact metamorphism. After viewing the films, begin Activity E-35. The concepts of the activity are abstractions and thus prevent any independent investigation at this time. Demonstrate each step in the directions, then instruct the students to follow your demonstration. Discuss each question before asking the students to write answers.

Several days will be required to complete the activity. Chapter 15 in the EARTH SCIENCE CURRICULUM PROJECT (ESCP), INVESTIGATING THE EARTH, Houghton Mifflin Co., 1967, page 330-346 is an excellent source for the student to read.

STUDENT

E - 35

DIFFERENCES IN METAMORPHIC ROCKS

Materials for groups of three:

1. Hand lenses
2. Diopside
3. Tremolite
4. Sandstone
5. Quartzite
6. Metamorphosed Conglomerate
7. Sedimentary Conglomerate

Two types of metamorphosis are contact metamorphosis and regional metamorphosis. What is the difference?

Contact metamorphism occurs where hot molten igneous rocks comes in contact with earth materials near in the earth. A hot material like lava from a volcano flows through or over a layer of rock, causing the rocks to be changed. Diopside and Tremolite are examples of minerals which are formed during contact metamorphism.

Regional metamorphism usually occurs at great depths in mountains. The tremendous pressure and heat alters the rocks. Some geologists say heat and pressure are required to form metamorphic rocks, others say all you need is pressure. To observe the changes compare a sedimentary conglomerate to a metamorphic conglomerate rock. also compare sandstone, the sedimentary rock, to quartzite, a metamorphic rock.

It is believed that several important changes occur during metamorphism.

1. Rocks are squeezed and the particles adjust themselves to the new pressures being elongated or stretched in the direction of least pressure. How does the sedimentary conglomerate which has been metamorphosed show this?
2. Rocks are packed tightly. With your hand lens, look at the white quartz grains in the sandstone and quartzite. Make a drawing of the two grains.

Student
page 2

Next, feel the surface of a sandstone - does it feel rough? This indicates the breaking around the grains. Feel the surface of the quartzite - does it feel smooth? This indicates a breaking across the grain.

Topic 4 - Igneous activity consists of movements of molten rock both inside and outside the earth's crust. Rocks formed from the molten rock materials are called igneous rock.

TEACHER RESOURCE

Igneous activity requires melted rock materials (liquid) called MAGMA. It is not known at exactly what depth magma forms, but evidence indicates that there are no extensive zones of molten rock within 18 miles of the surface of the earth. It is probably formed at depths no greater than 40 miles. These depths are calculated from present-day valcanoes. Any liquid will rise to a height comparable to the pressure applied ot it. The greater the pressure, the greater the height to which it will rise. This principle may be applied to volcanoes from 2,000 to 20,000 feet in height. It is believed that the pressure resulting from 15 to 20 miles or rock would be required to push the magma to the top of a 20,000-foot volcano. Over 2,000°F, is required to melt rocks of comparable composition to volcanio magma. The increase in temperature average 150° F per mile below the surface for an unknown depth, so at a depth of over 13 miles the temperature could be 2000°F.

Molten materials may supply enough heat to melt surrounding rock. As the molten material moves within or between rocks it fractures them and provides additional avenues for magma movement.

When magma within the crust loses its mobility, it solidifies in place, forming igneous rocks.

When the magma reaches the surface of the earth, it may blow out or pour along cracks in the earth's surface. As the lava accumulates it may pour from a single cone of a volcano.

As the magma cools mineral grains begin to grow, gas and vapors are given off, and it hardens into igneous rocks.

Teacher Resource
page 2

In general, the slow cooling of magma below the earth's surface produces to coarse-grained rocks. While cooling at or near the surface causes finer-grained rocks.

Most volcani rocks are basaltic, whereas many deep-formed rocks are graniti and coarse-grained, called plutonic rocks.

Some granite rocks are believed to be igneous in origin, as in batholiths, dikes, and sills, while others, as those formed as the cores in extensive mountain ranges are believed to be metamorphic in origin. These latter rocks have the same composition as clays and shales, and so are thought to be metamorphosed sediments.

TEACHER DIRECTION E - 36

IGNEOUS ROCKS

Materials for groups of three:

1. Pumice
2. Andesite
3. Horneblende
4. Rhyolite
5. Gabbro
6. Basalt

There are many unanswered questions regarding magma. The complexities of igneous-forming rocks are extensive. The great depth of magma formations develops from rock materials forming hot molten materials. The upward movement results in increased volume due to heat and cracks in the overlying rock strata. Much of the magma will not reach the surface.

The trip to the surface is interesting. New materials are melted and added to the magma. As the melted material moves upward, a cooling effect results, causing some minerals to crystallize and others to change in chemical composition. It is therefore difficult, perhaps impossible, to select a "typical" magma composition. The process seems well-established, but a specific explanation for "cause-and-effect" relationships are not clear. An excellent description can be found in Leet and Jusdon, PHYSICAL GEOLOGY, Prentice-Hall, 1965. References to films seen earlier will be valuable. Use a prepared acetate and red and black pens.

WHERE DOES VOLCANIC ROCK COME FROM? Hot melted rock. WHAT DO YOU CALL THIS MATERIAL? Lava. THIS ACETATE IS A DIAGRAM OF WHAT THE MELTED ROCK BELOW THE EARTH'S SURFACE "MAGMA". Color the dikes, sills, and laccoliths red. Explain the magma travel up the dikes, into the sills and laccoliths, or flows out of the volcano. Discuss the rate of cooling as the magma moves upward. Blacken the area of the volcano where lava comes out the side and top. WHAT WILL BE THE DIFFERENCE IN THE ROCKS FORMING AT THE SURFACE OF THE EARTH AND BELOW THE SURFACE OF THE EARTH. Grain size

Teacher Direction
page 2

will be larger below the surface. Discuss. WHO KNOWS WHAT WE CALL ROCKS FORMED FROM MELTED ROCKS? Igneous rocks. WHERE DOES THE ROCK COME FROM THAT MELTS TO FORM MAGMA. From below the surface and from rocks next to the flowing magma. This prevents us from showing exactly what original magma consists of chemically.

Use the rocks listed under materials for demonstration and read the student activity aloud.

Pass out E-36

Upon completion of the activity, discuss the findings, using a prepared acetate to formulate opinions about where rocks are formed.

Andesite, horneblende, and gabbro are crystallized deep below the earth's surface. Basalt, rhyolite, and pumice are formed near or on the surface. This can be determined by the mineral grain size.

Students are generally fascinated by volcanos. A library assignment to look up and write reports on volcanos may be attempted. Volcanos of interest are:

1. Mauna Loa, Hawaii (largest known)
2. Kilauea, Hawaii
3. Katamai, Alaska
4. Asama, Japan
5. Mount Pelée, West Indies
6. Mayon, Phillipine Islands
7. Tambora, Sumbawo Island
8. Vesuvius, Italy
9. Krakatoa, Java
10. Paracutin, Mexico

STUDENT

E - 36

IGNEOUS ROCKS

Materials for groups of three:

1. Pumice
2. Andesite
3. Hornblende
4. Rhyolite
5. Gabbro
6. Basalt

Igneous rocks are formed from hot, molten (melted) rock called magma, It is believed that magma forms deep in the earth, then works its way toward the surface. Sometimes the magma reaches the surface and flows along the surface, or it may erupt to form a volcano.

Volcanos have spells. They may explode violently, throwing lava, rock fragments, dust, and gases into the air. The volcano may remain quiet for hours or even years, or it may have a gentle flow of lava, or it may die and never erupt again. Magma doesn't always come to the surface, but instead may cool below the surface.

What would you expect the rocks from volcanos to look like? Probably they would consist of minerals formed below the surface.

You have six rocks. Divide them into separate groups according to the appearance of the rocks, and whether you think the rocks cooled above or below the earth's surface.

List the characteristics of each group.

ABOVE THE SURFACE

BELOW THE SURFACE

TEACHER DIRECTION E - 37

WHERE WILL IGNEOUS ROCKS GO?

This reading activity reinforces the rock cycle. Ask the students to read the activity, then read it aloud, discussing the important parts, using the prepared acetate. The terms weathering and erosion should be reviewed. Water, wind, and ice are the major eroding agents.

STUDENT

E - 37

WHERE WILL IGNEOUS ROCKS GO?

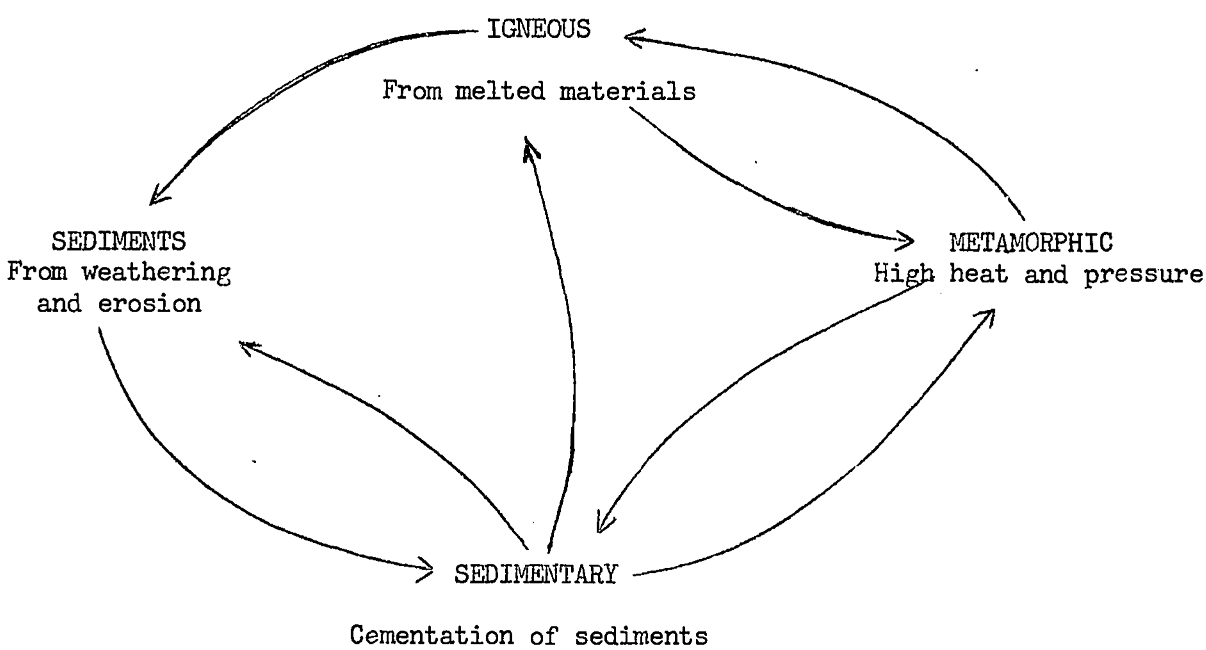
It seems that rocks are always in the process of going somewhere! How about igneous rocks? Do they change by weathering and erosion? Yes! All rocks undergo weathering and erosion when exposed to the hydrosphere and atmosphere. The chemicals in the water and in the air react with igneous rocks the same as they do with sedimentary and metamorphic rocks.

But, how do we know? If we were to drill a well in south Arkansas, we would find small flakes of volcanic lava, but we would have a hard time finding a volcano.. If we looked further north we would find a mountain of igneous rocks. Now, anyone in south Arkansas can tell you that one of the major rivers flowing through Arkansas runs right through the igneous rocks farther upstream, then across south Arkansas and into Louisiana. If you would talk to my grandfather, he would tell you how the rivers used to rise during the winter and flood many square miles of woods. If my grandfather was a geologist, he would tell you the flood waters were from the igneous rocks in north Arkansas as well as locally.

In 1783, a Japanese volcano named Asana and another named Lahi in Iceland had tremendous volcanic eruptions. Scientists during the year also reported "dry" fog in northern Africa and Scandinavia. At one place, the density of the fog was so great the sun was not visible until it had reached a position 17 degrees above the horizon. The winters of 1783-1784 were among the coldest on record. Benjamin Franklin was the first to publish the reason--volcanic, or igneous materials in the air above the earth. Other volcanic activities have been recorded demonstrating the wide effects of volcanic activity. Mayon in the Philippine Islands threw so much dust in the air that for three days there was an absolute darkness for a distance of about 300 miles. This dust accumulated as sediment which could be formed into sedimentary rock. These in turn could be burned.

Student
page 2

Igneous rocks, then like all other rocks may be part of a cycle called the ROCK CYCLE. It is shown as a wheel like this:



Why do they call this the rock cycle? Can you think of anything else a rock may be? If so, what?

TEACHER DIRECTION E - 38

VOLCANOES

Materials for teacher demonstration

1. Modeling clay
2. Ammonium dichromate

This is a reading activity on volcanoes to give the students some insight on the make up and causes of volcanoes.

Have the students to read over the activity. Afterward read over the activity with the students discussing the definition of terms and the different types of volcanoes. Explain mythology to them. When you have finished the discussion perform the demonstration to get their interest. Make an indentation in the top of a cone shaped mound of modeling clay large enough to hold three (3) tablespoons of ammonium dichromate. Light the chemical with a match or light a piece of magnesium ribbon extending from the chemical. Use a dark room to get a better effect. (Caution - the student should stand a few feet away from the demonstration).

Explain to the students that this is showing how volcanic cinder exude from a volcano, tell them they will observe the flow of lava and other characteristics of one volcano in the film.

Show film: THE ERUPTION OF KILAUEA. After the film entertain questions and comments. You may want to refer back to transparency E-36.

E - 38

VOLCANOES

STUDENT

The word volcano comes from the word Vulcan. According to mythology, vulcan was the Roman god of fire. It is also told that he was the blacksmith for the other gods. The terrific explosions were thought to be blasts from his furnaces. We now have other explanations.

A volcano is an opening in the earth's crust that acts as "safety values". Hot material escapes through them when there is great pressure under the ground. The opening is called a crater. Molten rock and gases that have been trapped in the earth comes up through the crater.

Is all the material below a certain level in the earth in a molten state? No. This molten state may be caused by a chemical action on the solid materials or it may be caused by some radioactivity. The molten material in the earth is called magma. When the magma pours from the earth it is called lava. This lava cools and in many instances builds up the land.

What causes these materials to come out of the earth? The cause may be the weight of the land pressing down on the molten materials. It may also be caused from a crack or fault (slipping) in the surrounding rock formations.

Some volcanoes are of the explosive type - erupting with terrific violence, blowing great quantities of lava and shattered rock high into the air. Some examples of these are Mount Katmai in Alaska, Paracutin in Mexico and Mount Hood in Oregon. There are also the quiet type that permits lava to ooze out slowly over the top or flowing out fissures on the sides of the cones. Some examples are Mauna Loa in Hawaii, Mount Rainier in Washington and Mount Etna in Sicily.

Volcanoes are frightening, yet magnificent to read and study about.

TEACHER DIRECTION E - 39

FORMATION OF FOSSILS

Materials for groups of three:

1. Plaster of paris
2. Leaf
3. Shell, sea
4. Vaseline
5. Mayonnaise jar cap

The students will be involved in a reading exercise on fossils to receive some background and afterwards do an activity on making some fossils.

To help in their comprehension of fossils show the film FOSSILS ARE INTERESTING, from the county library.

Bring out the fact that geologist use fossil remains to determine the age of the earth and the types of plants and animals that existed during a certain period.

Assist the students if necessary in making their fossil molds and emphasize the fact that they should have enough vaseline on their materials to prevent the plaster from sticking.

STUDENT E - 39

FORMATION OF FOSSILS

Materials for groups of three:

1. Plaster of paris
2. Leaf
3. Shell, sea
4. Vaseline
5. Mayonnaise jar cap

Uncountable billions of plants and animals have lived and died during the hundreds of millions of years that life has inhabited the earth. Relatively few of the organisms have left any record of their existence. The remains and traces left by these relatively few organisms are called fossils. The study of fossils is the science called paleontology. (PAY - LEON - TOLO - GEE) Fossils are formed by the remains of plants or animals being buried in mud, sand, volcanic ash, frozen ground or other material. The surrounding material has usually hardened into rock at a later time. The great majority of plants and animals that lived in the sea are most often found in limestone rocks. Those of land plants and animals are found most often in shale or sandstone rock.

To see how this could have been done we will do it artificially. Mix some plaster of paris in a beaker enough to fill up your jar cap (for better results add the water to your plaster of paris when mixing it). Pour your mixture in the vaseline lined jar cap. Place your shell, which is covered with vaseline to keep it from sticking, to the plaster and let it remain until the plaster hardens. When you remove the shell you should have an imprint of the shell. This imprint is a fossil mold. Follow the same procedure using your leaf.

From our activity we found that fossils are the remains of ____________ and ____________. We also found in one of our previous activities that most fossils are found in ____________________ rocks.

TEACHER RESOURCE

Earthquake - The shaking or trembling of the earth that is volcanic or tectonic in orgin.

Faulting is the principal cause of earthquakes, and nearly all the destructive earthquakes of history originated through faulting. But earthquakes do result from other causes. Of these, the most importat is volcanic eruption. A violent explosion of any kind, whether it be of gas, TNT, or a nuclear bomb, will rock the vicinity and shake the earth for varying distances. Violent explosions occur naturally in the eruptions of many volcanoes, and in some cases these have resulted in destructive earthquakes. In general however, such earthquakes are far less extensive and less damaging than those caused by faulting. Minor earthquakes of very limited extent may be caused by landslides and cave-ins of various kinds.

From the physiographic point of view, faulting is a constructional process. But to man, the earthquakes that follow faulting are among the most destructive of all natural occurrences.

The seismograph (syze - muh - graf) is an instrument used to detect and record earthquake shocks. It is sensitive enough to detect vibrations of the bedrock that are much too slight to be felt by man.

TEACHER DIRECTION

E - 40

EARTHQUAKES

In this activity we will try to enhance the students knowledge of the cause, detection and destruction of earthquakes with a reading activity and a film. Allow them to read over the activity once or twice to themselves then you read it aloud asking questions and receiving comments. Afterwards show them the film EARTHQUAKES, obtainable from your county film library to reinforce some possible misunderstandings.

Tell the students to observe the film to see what a seismograph looks like and how it works.

STUDENT E - 40

EARTHQUAKES

On August 31, 1886, the ground beneath the city of Charleston, South Carolina, shook slightly several times. Each tremor was a little more violent than the one before. The people in the city heard a distant rumble that seemed to approach the city. It sounded as though a hugh railway train were rushing through a tunnel under the town. The rumble increased to a roar. The ground seemed to rise and fall in waves. The violence lasted only a little more than a minute, but it was repeated eight minutes later.

During the shaking of the earth, people were unable to keep on their feet. Chimneys and walls were knocked down. Every single building in town was damaged. Many persons were killed by falling buildings. Narrow cracks called fissures (fish-erz), were opened in the earth, and railway tracks twisted. The shocks were felt as far away as Canada.

The sudden violent movement of a part of the earth's crust is called an earthquake. What causes earthquakes? One cause is the sudden slipping of the rock on two sides of a fault. (a crack in the earth's crust caused by pressure that displaces rock masses.) Most movements along faults are very slow and cannot be noticed. The edges of the two sides of a fault are not perfectly straight and smooth. The edges are jaggard. Jaggard edges of a fault may fit together as do the teeth of two saw blades placed cutting edge to cutting edge. Ordinary pressure in the earth's crust cannot move fault blocks that fit together so snugly. The pressure builds up tremendously until it is great enough to overcome the tight fit of the fault blocks. The result is a sudden springing of the earth's crust into a new position along the lines of the fault. This sudden springing movement causes earthquakes.

Student
page 2

TRY IT AND SEE!

Clench both fists. Place together the edges of the second-joint knuckles of each fist. The knuckle on one fist should fit into a notch between two fingers of the other fist. Press the fists tightly together. At the same time, push sidewise harder and harder until the knuckles suddenly slip over one another. In this way the sides of a fault suddenly slip past one another when enough pressure builds up in the earth's crust.

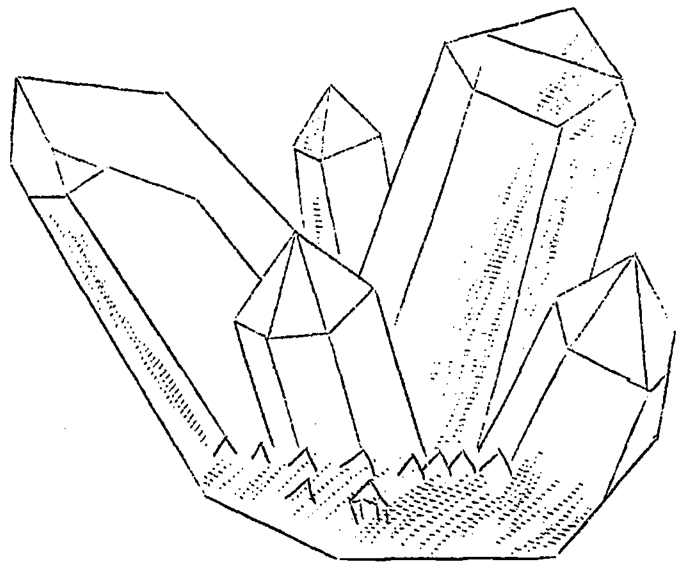
Earthquakes sometimes take place beneath the ocean. Great sea waves maybe caused by the movement of the earth. These waves may rise as much as 60 feet above the usual sea level. These hugh waves caused by earthquakes are sometimes called tidal waves or a tsunami (soo-NAH-me).

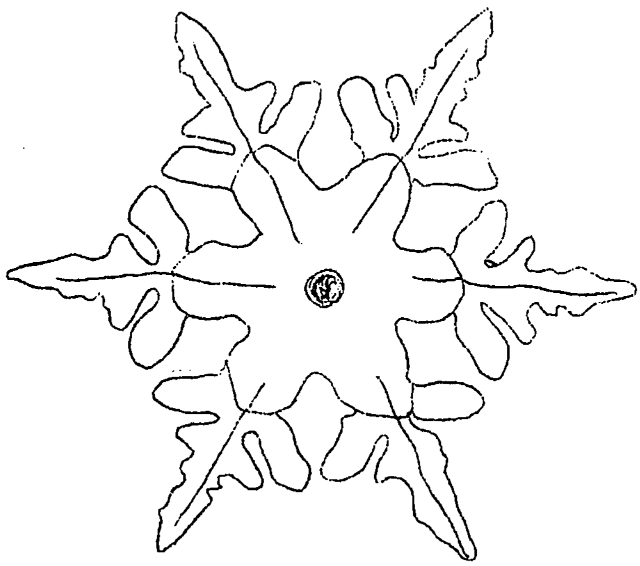
To find out when an earthquake will happen an instrument called a seismograph (syze-mah-graf) is used.

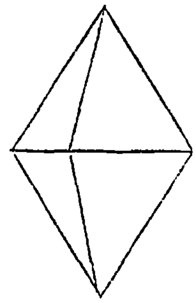
Scientist cannot tell us as much about the mighty storms underground as they can about the storm in the air. But every day they are learning more about the wonder of our earth.

UNIT 6

MINERALS AND CRYSTALS







UNIT 6

MINERALS AND CRYSTALS

Another way to classify minerals is to observe the crystal structure of that mineral. This unit is designed to show the difference between a morphous (containing crystals) substance and an amorphous (containing no crystals) substance. Also to familiarize the students with the growing of crystals and the basic system.

E-41	CLEAVAGE AND FRACTURE Film: CRYSTALS
E-42	GROWING CRYSTALS (ALUM) CUBIC SYSTEM
E-43	GROWING CRYSTALS (ROCHELLE SALT) ORTHORHOMBIC SYSTEM
E-44	GROWING CRYSTALS (NICKLE SULFATE) TETRAGONAL SYSTEM
E-45	CRYSTAL MODEL - PAPER FOLDING CUBIC, ORTHORHOMBIC, TETRAGONAL
E-46	GROWING A CHEMICAL GARDEN

TEACHER DIRECTION E - 44

CLEAVAGE AND FRACTURE

Identifying minerals by the way they break

Minerals for groups of three:

1. Knife
2. Razor blade (single edge)
3. Cloth
4. Hammer
5. Mica
6. Halite crystals
7. Calcite crystals
8. Quartz (uneven fracture)
9. Talc or graphite
10. Asbestos (serpentine)
11. Chert or flint

This activity is designed to show the students the difference between a substance cleaving and fracturing. When we mention the word crystal one should expect to see it break along the faces showing a clean cut at an angle. If a substance does not break or split leaving smooth surfaces it is not a crystal therefore it is said to fracture.

Allow the students to work through the activity assisting them if necessary. Bring out the fact that this is one of the ways to identify minerals. After the students have completed the activity and answered all of the questions show the film CRYSTALS as a culminating activity.

As an additional activity you may have the students to identify some "unknown" minerals. You could use the minerals used in previous activities. Consult the identification key of MODERN EARTH SCIENCE, Holt, Rinehart and Winston

STUDENT E - 44

CLEAVAGE AND FRACTURE

Identifying minerals by the way they break

Materials for groups of three

1. Knife
2. Razor blade (single edge)
3. Cloth
4. Hammer
5. Mica
6. Halite crystals
7. Calcite crystals
8. Quartz (uneven fracture)
9. Talc or graphite
10. Asbestos
11. Chert or flint

Some minerals break in interesting ways when you strike them. The way a mineral breaks can be used to identify them. When a mineral breaks or splits easily leaving smooth surfaces, this is called CLEAVAGE.

1. Use a knife to split a piece of MICA. Does it cleave easily?______________ See how thin a sheet you can split.
2. Place a razor blade parallel to the edge of a piece of HALITE. Hit the top of the blade gently with a hammer. What happens?______________
3. Wrap a piece of CALCITE with a cloth. Hit it with the hammer. What does the pieces look like?____________________________________

   Draw a few of them.

When a mineral does not break or split leaving smooth surfaces, this is called FRACTURE. There are many different kinds of fractures described in such terms as UNEVEN, FLAKY, SHELL-LIKE OR CONCHOIDAL AND FIBROUS.

1. Look at a piece of <u>QUARTZ</u>. What kind of fracture does it have?______________
2. Chip off a small piece of <u>TALC OR GRAPHITE</u>. Does it appear to have a flaky fracture?____

Student
page 2

3. Break and pull apart a piece of ASBESTOS. Describe its fracture.

4. Examine pieces of FLINT or CHERT. What kind of fracture does this mineral have?____________________ Notice the sharp edges. How did the Indians use this mineral?____

After you have answered all of your questions and cleaned your area ask your teacher to show you the film on crystals.

TEACHER RESOURCE CRYSTALS AND CRYSTAL GROWING

Crystals are solids with a natural geometric form. They may be cubes, rectangles, or complex geometric figures. A crystal reflects the internal structure of the mineral or substance, since the crystal form is the structural form of molecules that make up the mineral. Crystal shape can be an important means of identifying minerals.

Certain factors regulate the growth of crystals: the temperature of the liquid that contains the dissolved material; the rate of evaporation of the solution; the presence of foreign particles in the solution; the degree of supersaturation of the solution; and the tendency of the particular substance to crystalize or form crystals.

A crystal does not suddenly spring into being; it grows into being. A growing crystal does not grow from within as man does; but it has to grow from outside - from the material presented to its surface. They grow until something gets in their way or until they get in one another's way.

Cyrstals grow under many different conditions - some of them quite surprising. Snow flakes grow directly from moist air. Some crystals grow from hot melted metal. But the most familiar method of growing crystals is from a solution in a liquid - in other words from a second substance which stays liquid or evaporated while the solid separates out.

Almost all salts can be crystallized from the most abundant liquid, water. In our experiments we will be using water as the liquid as we crystallize various salts.

One 16MM film available from the audio-visual department of the Duval County School Board will be of interest and helpful to the students as they begin their study of crystals.

Teacher Resource
page 2

The film is: CRYSTALS

Ask the students to bring in small jars - baby food jars or half pint jars. Large jars are unsoitable for making crystals.

These jars will be needed for E-45, E-46, and E-47. Each student will need 3 jars. Have the students to thoroughly clean all jars before the day of the experiment.

STUDENT RESOURCE

CRYSTALS AND CRYSTAL GROWING

Usually in an earth science class we will discuss crystals in the mineral section, but because they play an important role in identifying minerals we are going to discuss crystals as a separate unit.

There are a few facts we would like to mention which may help you to understand the activities better.

Crystals are solids with a natural geometric form. They may be cubes, rectangles or complex geometric figures. A crystal reflects the internal structure of minerals or other substances.

There are certain factors that regulate the growth of crystals. The temperature of the liquid that contains the dissolved material; How fast the solution evaporates; The presence of foreign particles (dust, chemicals, etc); The degree of supersaturation; and the trend of the particular substance to crystallize or form crystals.

We mentioned the word supersaturated, this means a solution holds more of a substance than it can dissolve.

A crystal does not suddenly spring into being; it <u>grows</u> into being, a growing crystal does not grow from within as man does; but it has to grow from outside - from the material its surface comes in contact with.

There are many methods used in growing crystals, some take a long time to grow such as the crystals in some igneous rocks, but in our activities we are going to use water as our liquid and grow crystals from various salts. Some will cause rapid growth and others will take longer.

If you would like to learn more about crystals go to your library and read some books on crystals, they can be interesting.

TEACHER DIRECTION E - 42

GROWING CRYSTALS (ALUM CUBIC SYSTEM)

Materials for groups of three:

1. Alum (4 teaspoons)
2. Beaker (400 ml)
3. Three small jars (cleaned)
4. String
5. 3 pencils or small pieces of stick
6. Asbestos gauze
7. Alcohol or bunsen burner
8. Tripod or ring stand
9. Stirring rod

This experiment in crystal growing will take several weeks (two to three) to complete. Interest in the experiment should be generated each day to see how the crystal growing is progressing. When the student has completed this experiment he may take the crystal he has grown home with him.

IN THIS LESSON WE ARE GOING TO MAKE ANOTHER SUPERSATURATED SOLUTION. THIS TIME WE WILL MAKE A SUPERSATURATED <u>ALUM</u> SOLUTION. IF WE WORK VERY CAREFULLY, WE CAN MAKE SOME PRETTY CRYSTALS GROW IN THE LITTLE JARS. WHO DO YOU THINK CAN GROW THE BIGGEST AND PRETTIEST CRYSTALS IN THE CLASS?????? (Discuss how crystals grow. Refer to material in Teacher Resource at beginning of unit.)

HERE IS WHAT WE WILL DO. LET'S BOIL ONE CUP OF WATER IN THE BEAKER. (Pause) NOW THAT YOU HAVE BOILED THE WATER, DIVIDE IT EQUALLY INTO THE THREE SMALL JARS EACH OF YOU HAVE. WRITE YOUR NAME ON THE LABEL AND PLACE IT ON YOUR JARS.

ADD TWO TEASPOONS OF ALUM TO THE HOT WATER IN THE JAR. STIR IT UNTIL ALL OF THE ALUM IS MIXED IN THE WATER. ADD A LITTLE MORE ALUM TO THE WATER AND BE SURE THAT ALL OF IT MIXES. (Pause) KEEP ADDING A VERY SMALL AMOUNT OF ALUM UNTIL YOU FIND THAT NO MORE ALUM WILL DISSOLVE IN THE WATER. NOW YOU HAVE PUT IN ENOUGH ALUM TO MAKE THE SOLUTION SUPERSATURATED.

LET THE SOLUTION COOL VERY SLOWLY.

Teacher Direction
page 2

WHILE THE SOLUTION IS BEGINNING TO COOL, TIE A SEED OF ALUM TO A STRING USING A SLIP KNOT (show acetate on overhead projector). TIE THE OTHER END OF THE STRING AROUND THE MIDDLE OF THE PENCIL (or stick). (Teacher: Be sure the string is long enough to go down into the solution but short enough so that it will hang straight down in the jar). BE SURE THAT THE SEED DOES NOT EXTEND ABOVE THE SURFACE OF THE SOLUTION. THE STRING ACTS AS A WICK: AS WATER EVAPORATES FROM THE WICK ADDITIONAL SEEDS FORM ON IT.

(Teacher: Check each jar to be sure the seed has been properly placed in the solution and that the string is hanging straight down in the jars).

SINCE TEMPERATURE CHANGES AFFECT THE DEGREE OF SUPERSATURATION, WE WILL WANT TO KEEP THE JARS WHERE THEY WILL NOT BE DISTURBED AND WHERE THE TEMPERATURE VARIES THE LEAST. (Instruct students where to place their jars. This should be somewhere that they can view the jars each day and yet be where the temperature remains fairly constant.)

BARBER SHOPS KEEP ON HAND A SMALL PENCIL MADE OF ALUM. IT IS CALLED A STYPTIC PENCIL AND IS USED TO STOP BLEEDING FROM SMALL CUTS. IF THE BARBER ACIDENTLY MAKES A SMALL CUT ON A CUSTOMER'S FACE WHILE SHAVING HIM...HE APPLIES THE END OF THE PENCIL TO THE WOUND. THE NEXT TIME YOU ARE AT THE BARBER SHOP ASK THE BARBER TO SHOW YOU HIS ALUM PENCIL. HOW DOES THE ALUM PENCIL HELP THE BARBER STOP THE BLEEDING. ALUM IS A WHITE CRYSTAL SUBSTANCE WHICH SHRINKS OR DRAWS TOGETHER THE TISSUES OF SKIN. SHRINKING THE SKIN AROUND A CUT STOPS BLEEDING.

STUDENT E - 42

GROWING CRYSTALS (ALUM) CUBIC SYSTEM

Materials for groups of three:

1. Alum
2. Beaker (400 ml)
3. Small jars (3)
4. String
5. Pencils or small sticks (3)
6. Alcohol burner
7. Asbestos gauze
8. Tripod
9. Stirring rod

Be sure that your coffee can and jars are clean. Put your name on a label and stick it to your jar. Boil one cup of water in the coffee can. Divide the water equally into the three jars. Add two teaspoons of alum to the hot water in each jar. Stir it until all of the alum is mixed in the water. Add a little more alum to the water and be sure that it all mixes. Keep adding very small amounts of alum to the water until no more alum will go into the solution.
Let the solution cool very slowly.

While the solution is cooling, tie the seed of alum with a piece of string by making a slip knot as shown in the transparency on the screen.

After you have fastened the seed to the string, tie the string around the middle of the pencil. Be sure the string is long enough so that the seed will reach into the solution but still hang straight down into the jar. As shown on the transparency.

Place the jars where they will not be disturbed and where the temperature will vary little. In a few days the crystal should start to grow.

TEACHER DIRECTION E - 43

GROWING CRYSTALS (ROCHELLE SALT)
ORTHORHOMBIC SYSTEM

Materials for groups of three:

1. Rochelle Salt
2. Beaker (400 ml)
3. Three small jars
4. String
5. 3 pencils or small piece of stick
6. Asbestos gauze
7. Alcohol or Bunsen burner
8. Ring stand
9. Stirring rod

In this activity have the students to follow the directions given for the alum crystals.

Next to alum, Rochelle salt is best suited for an initial attempt at crystal growing. In growing Rochelle salt, the seed solution often supersaturates without depositing any seeds. Should no seed appear within two days, add a very few Rochelle salt particles from the supply bag. Once started, the seeds will probably grow very quickly, and therefore the students should inspect them twice a day.

The fact that the solubility of Rochelle salt varies greatly with temperature, the students must be careful to observe and control the temperatures at which they work; it is easy to lose the planted seed by dissolving it off the thread before the solution becomes supersaturated.

Some of the chemicals may not have crystals large enough to be tied as seeds, therefore the students or maybe you can prepare some seed crystals using this method: POUR AN OUNCE OF YOUR SATURATED SOLUTION INTO A SMALL GLASS AND SETTING IT IN AN UNDISTURBED PLACE. AS THE SOLUTION EVAPORATES, A FEW CRYSTALS WILL USUALLY BEGIN TO GROW ON THE BOTTOM OF THE GLASS. IF IT BECOMES SUPERSATURATED WITHOUT DEPOSITING CRYSTALS, ADD A VERY SMALL AMOUNT OF CRYSTALLINE POWDER FROM THE SUPPLY BOTTLE, OR OF THE POWDER LEFT AFTER EVAPORATING A DROP OF SOLUTION. LOOK AT THE GLASS AND ITS CONTENTS ONCE OR TWICE A DAY: HARVEST THE SEEDS WHEN THEY HAVE GROWN LARGE ENOUGH FOR CONVENIENT HANDLING.

STUDENT DIRECTION

E - 43

GROWING CRYSTALS (ROCHELLE SALT)
ORTHOROMBIC SYSTEM

Materials fro groups of three:

1. Rochelle Salt
2. Beaker (400 ml)
3. Three small jars
4. String
5. 3 pencils or small sticks
6. Asbestos gauze
7. Alcohol or bunsen burner
8. Ring stand
9. Stirring rod

You will follow the same procedure with the rochelle salt as you did with the alum, except you may have to use more rochelle salt to get a supersaturated solution.

Draw a picture of your crystal after a couple of days.

TEACHER DIRECTION

E - 44

GROWING CRYSTALS (NICKLE SULFATE)
TETRAGONAL SYSTEM

Materials for groups of three

1. Nickle sulfate
2. Beaker (400 ml)
3. Three small jars
4. String
5. 3 pencils or small sticks
6. Asbestos gauze
7. Alcohol or bunsen burner
8. Ring stand
9. Stirring rod

Again the students will follow the same procedure as before. In making the seed for this crystal you may have to use more of the chemical to reach its saturation point.

STUDENT DIRECTION E - 44

GROWING CRYSTALS (NICKLE SULFATE)
TETRAGONAL SYSTEM

Materials for groups of three:

1. Nickle sulfate
2. Beaker (400 ml)
3. Three small jars
4. String
5. 3 pencils or small sticks
6. Asbestos gauze
7. Alcohol or bunsen burner
8. Ring stand
9. Stirring rod

Follow the same procedure as before and draw a picture of the crystals after a few days.

TEACHER DIRECTION E - 45

CRYSTAL MODELS - PAPER FOLDING

Materials for groups of three:

1. 3 paper patterns for alum crystals
2. Scissors (3 pair if available)
3. Glue

Stimulate interest in today's activities by first discussing how we can tell what the composition of the crystal is by its characteristic shape.

WE HAVE FOUND THAT CRYSTALS ARE NON-LIVING SUBSTANCES WHICH GROW INTO BEING BY ADDING MORE AND MORE LAYERS OF THE SAME SUBSTANCE KEEPING THE SAME SHAPE AT ALL TIMES.

JUST AS WE CAN TELL EACH OTHER APART BY THE CHARACTERISTICS OF OUR APPEARANCE... SO WE CAN TELL ONE KIND OF CRYSTAL FROM ANOTHER BY ITS SHAPE. FOR EXAMPLE - SALT CRYSTALS ARE SHAPED LIKE LITTLE CUBES (Show transparency on overhead.) HOW MANY SIDES DOES THE SALT CRYSTAL HAVE? LET'S COUNT THEM. (Discussion). THE NEXT PICTURE IS THE SHAPE OF A CRYSTAL OF SUGAR. HOW DOES IT DIFFER FROM THE SHAPE OF THE SALT CRYSTAL WE HAVE JUST LOOKED AT??? (Discussion)

WHAT SHAPE DO YOU THINK THE ALUM CRYSTAL THAT WE ARE GROWING WILL HAVE? (Discussion) WE HAVE A PICTURE OF THE ALUM CRYSTAL ON THE SCREEN (Show transparency of alum crystal). Explain the shape of the alum crystal is a double 4-sided pyramid. Each side is in the shape of a pyramid.

LET'S MAKE A MODEL OF THE ALUM CRYSTAL. YOU MAY LIKE TO MAKE SEVERAL OF THESE MODELS AND WE CAN SEE HOW THE CRYSTALS WILL FIT TOGETHER.

(Pass out student activity sheet E-45 and a pair of scissors and glue to each student.)

CUT OUT THE FIGURE ON THE ACTIVITY SHEET E-45 MAKING SURE YOU CUT THE LINES AS STRAIGHT AS POSSIBLE. (Pause

Teacher Direction
page 2

FOLD THE SIDES OF THE TRIANGLES ALONG THE LINES MARKED FOLD. (Teacher could make a larger scale model to illustrate how to fold and glue model into correct positions).

NOW TUCK UNDER THE LITTLE TABS TO SEE IF YOUR MODEL IS GOING TO FIT SMOOTHLY. (Pause) WE ARE READY NOW TO PUT A SMALL AMOUNT OF GLUE ON EACH OF THE FIVE TABS AND STICK THEM INTO PLACE. HOLD ONTO THE MODEL MAKING SURE THAT THE TABS STAY WELL GLUED. CAN YOU SEE THE DOUBLE PYRAMID SHAPE?

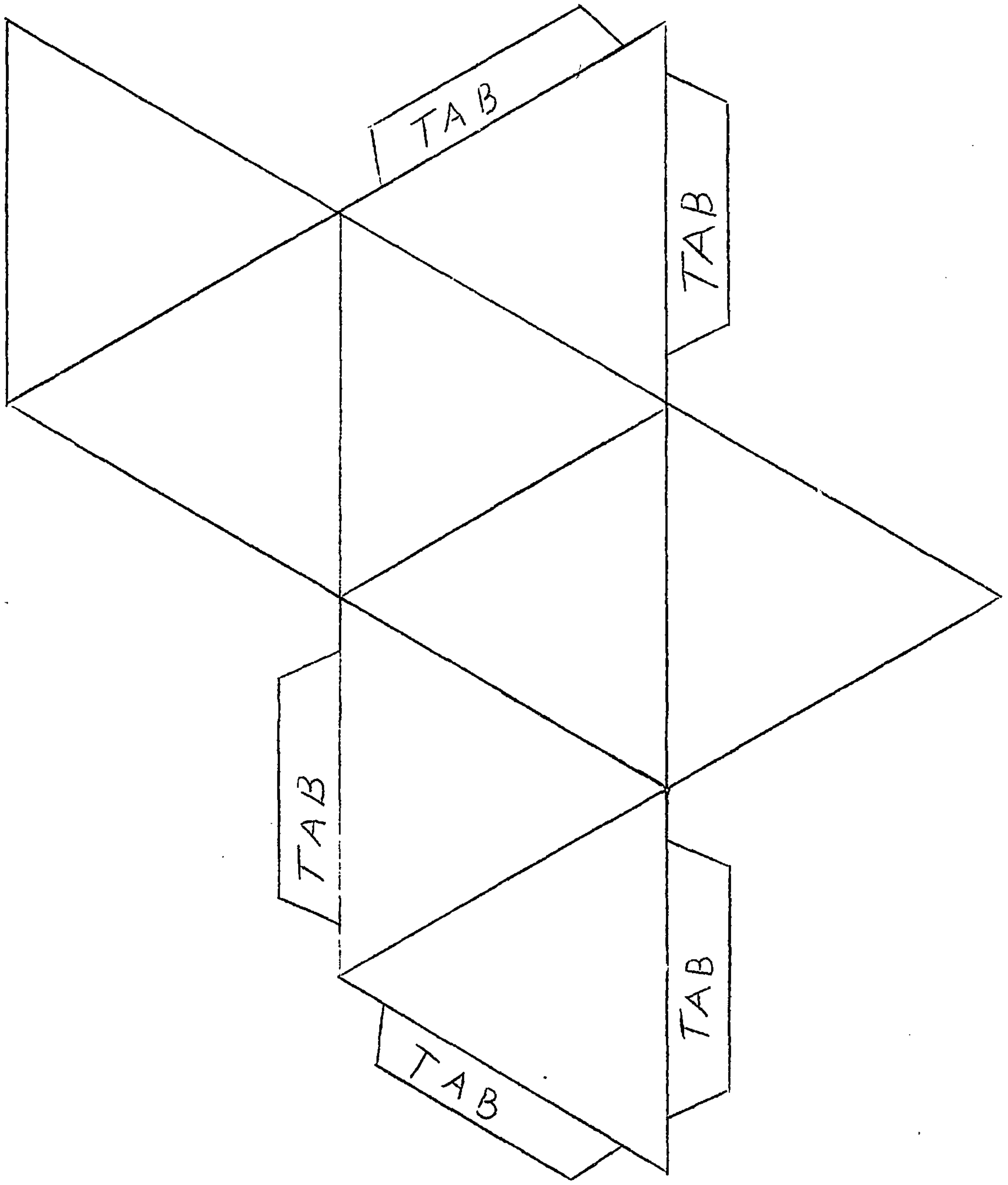
THIS IS THE SHAPE OF THE ALUM CRYSTAL WE ARE MAKING IN THE SOLUTIONS WE PRE-PARED EARLIER. AS OUR CRYSTALS BEGIN TO FORM IN A FEW DAYS WE CAN COMPARE THEIR SHAPE WITH THOSE OF OUR MODELS.

Follow the same procedure as the alum model and let the students make paper models of the four basic crystal systems they used.

YOU MIGHT MENTION ALL OF THE CRYSTALS FORMED BELONG TO ONE OF THE SIX "CRYSTAL SYSTEMS".

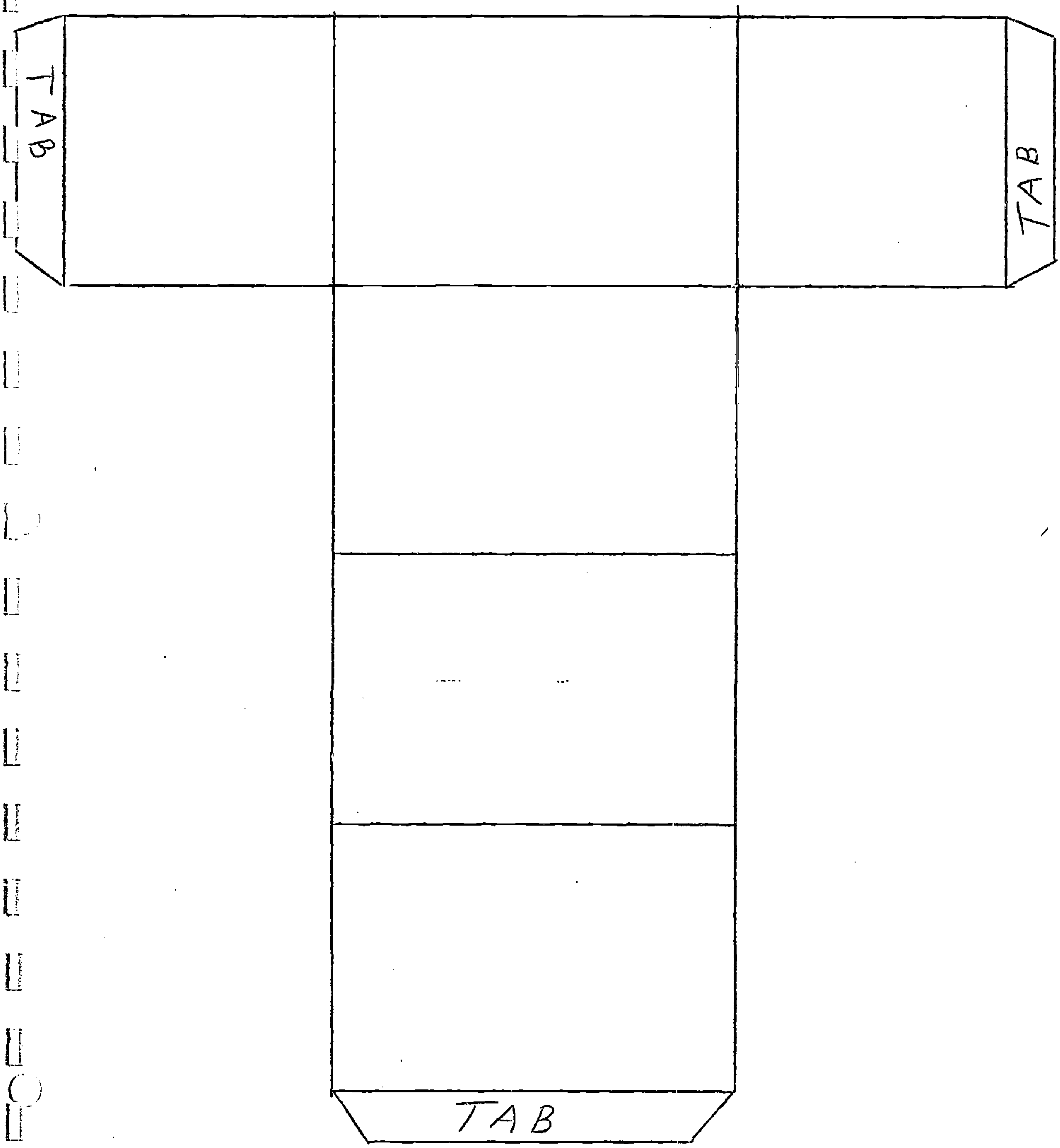
Student
page 1

CRYSTAL MODELS - PAPER FOLDING
(ALUM)



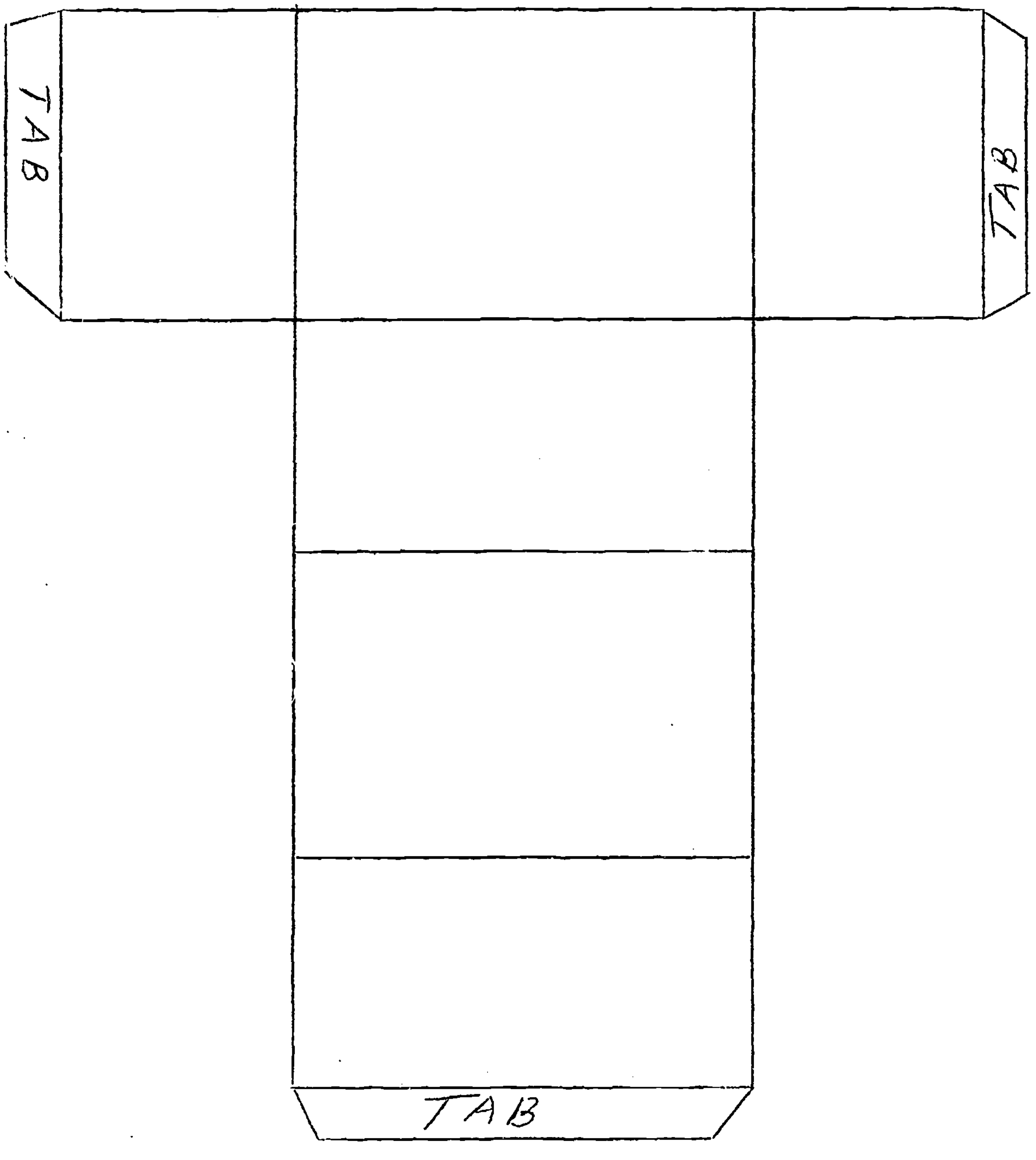
Student
page 2

TETRAGONAL
(Nickle Sulfate)



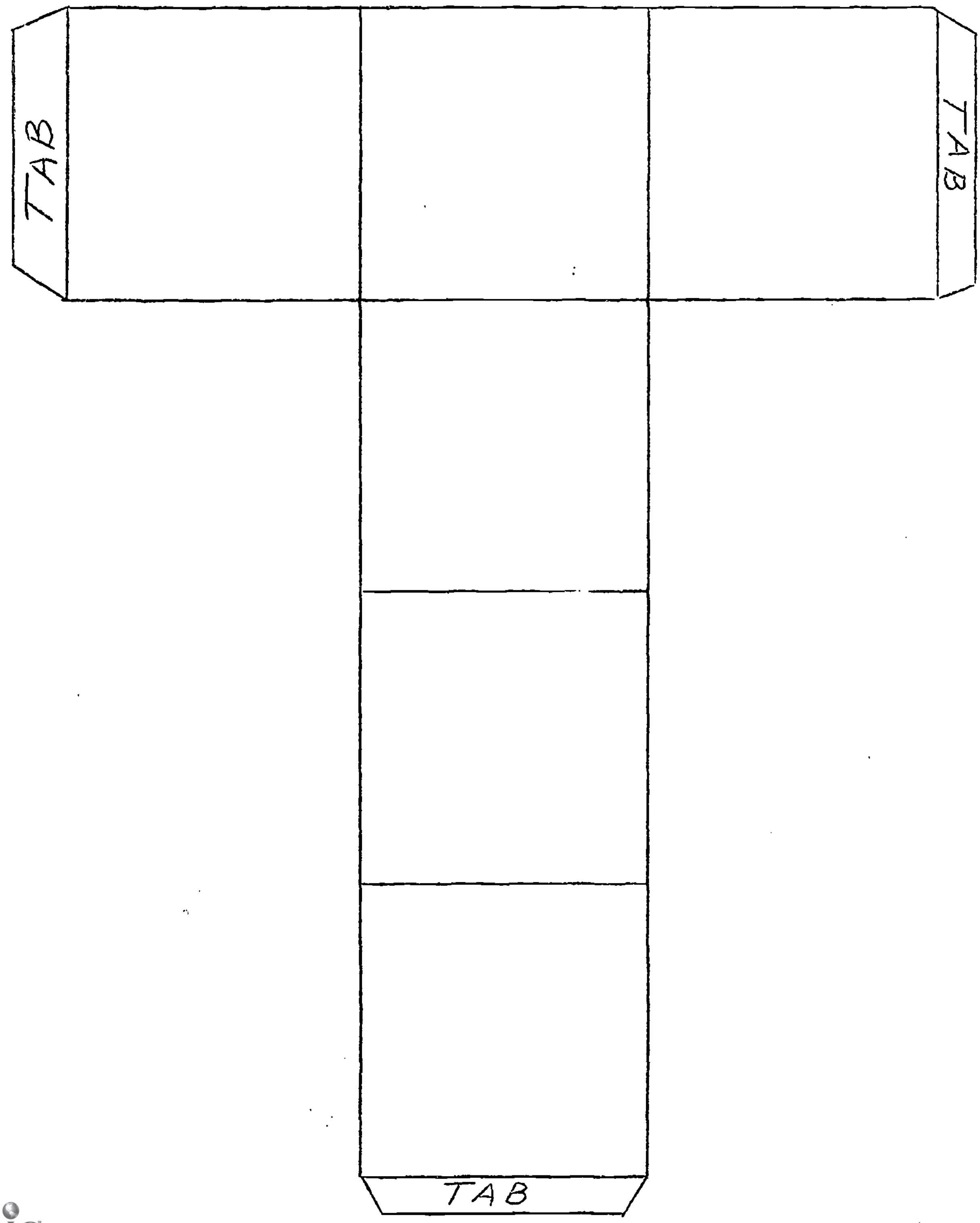
Student
page 3

ORTHORHOMBIC
(Rochelle Salt)



Student
page 4

CUBIC
(Alum)



TEACHER DIRECTION E - 46

GROWING A CHEMICAL GARDEN

Materials for groups of three:

1. 3 jars (about ½ pint to pint size)
2. Beaker
3. Sand
4. Sodium silicate
5. Iron chloride
6. Copper chloride
7. Potassium Nitrate
8. Labels
9. Measuring cup
10. Copper sulfate

Give the students a chance to try out their "chemical" green thumb with this activity of growing a chemical garden. THIS MIGHT BE TERMED "GETTING A HEAD-START ON SPRING."

IN THIS ACTIVITY WE ARE GOING TO SEE THE WAY SILICATES FORM FROM SEED CRYSTALS AND THESE CRYSTALS WILL BLOOM INTO A BEAUTIFUL CHEMICAL FLOWER GARDEN. PUT 1/8 to 1/4 INCH OF SAND IN THE BOTTOM OF YOUR JAR. PLACE A LABEL WITH YOUR NAME ON THE JAR. (Pause)

MAKE A SOLUTION OF 1/4 CUP SODIUM SILICATE TO A CUP OF WATER. STIR IT WELL. (Pause).

SPRINKLE A SMALL QUANTITY OF IRON AND COPPER CHLORIDES, POTASSIUM NITRATE, AND COPPER SULFATE. THE PARTICLES YOU SPRINKLE IN THE JARS SHOULD BE NO LARGER THAN THE HEAD OF A PIN. USE THEM SPARINGLY... SO THAT YOU WILL HAVE A BEAUTIFUL GARDEN. (Pause). NOW LET'S LEAVE THE JARS ON THE TABLES FOR A LITTLE WHILE AND KEEP OUR EYES ON THEM. BEFORE TOO LONG COLORFUL FLOWERS WILL START TO GROW. HOW DO YOU THINK THEY WILL GROW?

Teacher Direction
page 2

THE CRYSTALS WILL RUPTURE BECAUSE OF INTERNAL PRESSURE AND WILL BUILD UP LAYER UPON LAYER. WE HAVE ALREADY LEARNED THAT CRYSTALS GROW FROM ONE LAYER BUILDING UPON ANOTHER LAYER. IN A FEW DAYS WE WILL FIND THAT THE CRYSTALS OF SILICATE WILL HAVE GROWN INTO A BEAUTIFULLY COLORED GARDEN.

WE CAN PRESERVE THIS GARDEN AFTER THE CRYSTALS HAVE STOPPED GROWING BY SIPHONING OFF THE WATER GLASS SOLUTION AND REPLACING IT WITH CLEAR WATER. THEN WE MAY TAKE OUR CHEMICAL GARDENS HOME...THEY WILL KEEP FOR A VERY LONG LONG TIME.

STUDENT

E - 46

GROWING A CHEMICAL GARDEN

Materials for groups of three:

1. 3 jars (about ½ pints to pint size)
2. Beaker (250 ml) (3)
3. Sand
4. Sodim silicate
5. Iron chloride
6. Copper chloride
7. Potassium Nitrate
8. Labels (3)
9. Measuring cup
10. Copper sulfate

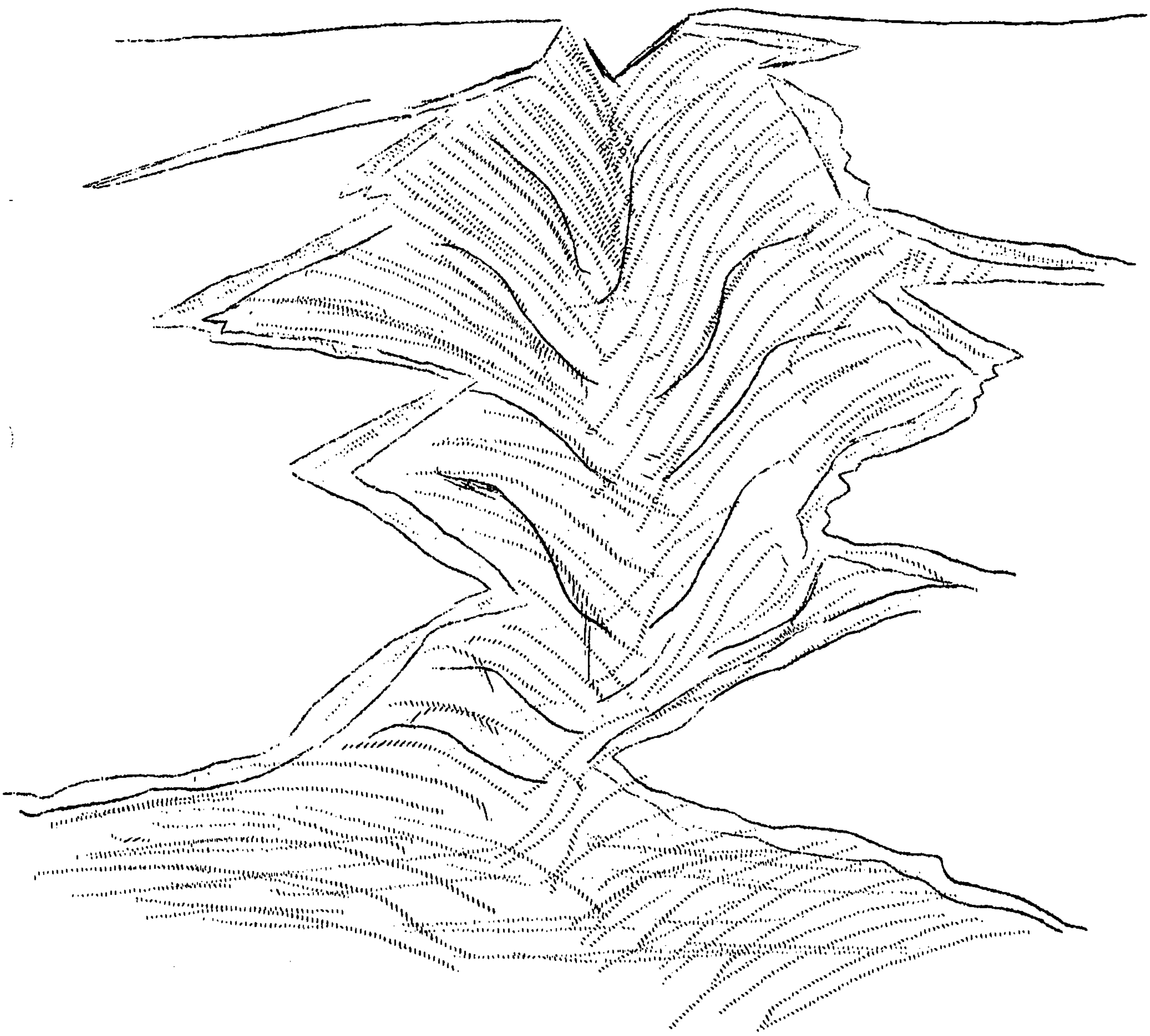
Place a label with your name on it on your jar. Put 1/8 to 1/4 inch of sand in the bottom of the jar. Make a solution of 1/4 cup of sodium silicate to a cup of water. Stir the solution well. Pour the solution in your jar.

Sprinkle a small amount of iron and copper chloride, potassium nitrate and copper sulfate in the jar. The particles you use should be no larger than the head of a pin.

Let the jars stay on the table for a little while. Keep your eyes on the jars. Before very long beautiful flower crystals will start to grow.

What colors are the flowers in your chemical garden?________________

UNIT 7
WEATHERING AND EROSION



UNIT 7

WEATHERING & EROSION

This unit is designed to give the students some insight on weathering and erosion, it causes and effects.

E-47	WEATHERING DUE TO TEMPERATURE CHANGE
E-48	ACID AND LIMESTONE
E-49	HOW SAND IS FORMED
E-50	WIND EROSION Film: EROSION

TEACHER RESOURCE

Weathering is a general term applied to processes operating at or near the earth's surface that causes rocks to rupture into small fragments, dissolve, decompose and form new minerals, and by a combination of such events form soil. One should understand, however, that weathering disrupts and alters rocks but that the removal of such altered debris is erosion and not weathering.

Although all weathering processes proceed simultaneously toward the development of their end products, the rate of progression varies as rock and climatic condition dictate. Weathering is subdivided into physical, chemical, and biological processes. Physical processes rupture the existing rocks causing small fissures to appear, and generally fragment rocks. Dominant is the splitting action due to ice forming in fractures. Expansion and contraction of rock surfaces. Caused by repeated heating and cooling are also significant in weakening and rupturing rock. Chemical weathering is more varied than physical weathering and also is more important in the development of soil. Chemical weathering are in four major types, carbonation, oxidation, hydration and leaching. Biological processes include the physical effects of splitting of rocks by roots growing in fissures, grinding and abrading of rock fragment by burrowing and digging organisms, and grinding and dissolving of particles by organisms such as earth worms which eat soil for its contained organic matter. After rock is reduced to small particles by weathering, it may be removed to other locations by erosion. The means by which erosion is accomplished depends to a large extent upon the climate of the locality. In dry climates, the wind is most effective in picking up the rock grains and moving them, often for great distances. The windborne rock grains also have an abrasive action on unweathered rock. Thus wind is an agent of weathering and erosion.

Teacher Resource
page 2

In most climates, the most important agent of erosion is moving water. The work of waves and currents is effective along shores of oceans and lakes.

Water is also a powerful agent of erosion in the form of glacial ice. Moving ice transports large rock fragments which act as sharp cutting tools to scour the solid bedrock as the glacier moves.

Another agent of erosion works in a much less obvious way than those already mentioned. This is gravity, which is a constant factor on the earth. It is surprisingly effective in eroding the weathered rock.

TEACHER DIRECTION E - 47

WEATHERING DUE TO TEMPERATURE CHANGE

Materials for groups of three:

1. Tongs
2. Beaker
3. Alcohol or bunsen burner
4. Staurolite in Schist

In your discussion of the rock cycle you may have mentioned to the students how rocks are weathered and form sand. To show this in actuality the students can observe how sudden changes of temperature may cause rocks to split into smaller pieces by using staurolite in schist (small pieces from a previous activity in the rock cycle) some water and a bunsen or alcohol burner. In doing this activity the students will see small particles falling away from the staurolite after they have heated it and put into some water.

After the students have done the activity you may go over the questions to insure comprehension and you might ask them if they know of any other temperature change that will cause rocks to split. If there are no responses have some of the students to take a test tube and a stopper or cork home and tell them to fill it to the brim and put the stopper on it and set it in the freezer overnight. Tell them to mark the test tube where the stopper has gone in and put the test tube in a paper bag. When the students return discuss their findings.

STUDENT E - 47

WEATHERING DUE TO TEMPERATURE CHANGE

Materials for groups of three:

1. Tongs
2. Beaker
3. Alcohol or bunsen burner
4. Staurolite in Schist

In talking about the rocks in the rock cycle the word weathering was mentioned this means the natural breaking or splitting of rocks and minerals. What do you suppose causes this to happen to rocks and minerals? There are several things that might cause this but we are going to discuss one of them in this activity.

Obtain the materials needed for your group. One student will fill the beaker three-fourths (3/4) full of water, another will light the burner, the last person will take the tongs and hold a piece of staurolite in the flame for ten (10) minutes then put it into the water. Observe what happens.

What happened to the staurolite when it was put into the water?______________ ____________________ What caused this to happen?____________________ What could we call the particles that fell from the staurolit?____________________

TEACHER DIRECTION

E - 48

WEATHERING BY CHEMICAL ACTION

Materials for groups of three:

1. Dilute Hydrochloric Acid
2. Limestone, Small pieces
3. Beaker (200 ml)

In the previous activity we discussed the effects of mechanical weathering on rocks. This activity will be concerned with the chemical aspects of weathering. In chemical weathering, reactions take place between minerals in the rock and carbon dioxide, oxygen and water. These reactions alter the composition of the rock minerals. We are going to base our activity on the carbon dioxide and water reaction. We will use HCI as our carbonic acid to show the effect better, we could have used CO_2 from our breath and limewater but the conditions would have to be just right.

After the students have finished the activity go over the questions and answer the questions the students might have.

STUDENT E - 48

WEATHERING BY CHEMICAL ACTION

Materials for groups of three:

1. Acid
2. Limestone, small pieces
3. Beaker (200 ml)

In nature rainwater as it falls to the earth absorbs a certain amount of carbon dioxide from the air. As it enters the soil additional carbon dioxide is absorbed from plants and animals. Water is combining with the carbon dioxide and forms a weak acid called carbonic acid. This is the same acid which is contained in a coke or 7 up or other soft drinks. As the water containing this acid comes in contact with limestone a reaction occurs causing the limestone (calcium carbonate) to dissolve and release carbon dioxide gas. The end result is a complete weathering of the limestone. Later the water containing this dissolved limestone will evaporate leaving behind the limestone in the form of calcite (a mineral) or in the form of stalactites and stalagmites as seen in many natural caves in the U.S.

To see how this takes place put a few pieces of limestone in a beaker and pour some acid over them. What do you notice taking place?______________________
Does the clear liquid turn milky?______________ Why?__________________________
What could you call the particles at the bottom of the beaker?_________________
What can you say is contained in ground water which causes limestone to dissolve over a period of time__________________________

TEACHER DIRECTION E - 49

HOW SAND MAYBE FORMED

Materials for groups of three:

1. Jar, pint 2. Limestone chips 3. Pea gravel

What we would like to have brought out in this activity is the fact that weathering and erosion work together but there is a difference between them. Also we would like to point out that sand maybe formed and also the rounding of pebbles flowing along in a river bed.

In your discussions you may ask the students to name some of the erosion agents. Pass out the activity and let the students have at it.

STUDENT DIRECTION E - 49

HOW SAND MAYBE FORMED

Materials for groups of three:

1. Jar pint (with top)
2. Limestone chips
3. Pea gravel
4. Beaker (250 ml)

Erosion of rocks is a phenomenon that occurs naturally whenever conditions favoring their formations are found. The most common occurrance of "pebbles" is to be found in areas with rapidly flowing streams or rivers. A tumbling action takes place. The stones rub against each other on the stream bed. By this abrasive effect the corners are broken or worn down on the irregular rocks and a rounded rock or pebble results.

Winds causes some rounding of pebbles by moving the pebbles from one place to another and cause the pebbles to hit against larger rocks which tends to wear away a part of the pebbles.

Let's see if we can illustrate these ideas in our class.

Put 100 ml of pea gravel and 100 ml of limestone chips in your jar. Add 200 ml of water. Shake vigorously for 10 minutes. Examine to see if the limestone chips have been changes at all. Repeat the process until you are convinced of the grinding abrasive action that occurs when rock tumble over each other in a stream bed. Take the limestones and pea gravel out of the jar being careful not to pour out any of the water. Did the limestone chips become rounded? ______________ Are there any rock materials left in the jar?________________ What would you call this material?____________________

Set up your materials as before but do not use any water. Shake the jar for 10 minutes. Did the limestone chips become rounded? ___________ Are there any rock materials left in the jar?______________ What would you call this materials? ___________________________________

TEACHER DIRECTION

E - 50

WIND EROSION

Materials for groups of three:

1. Sand
2. Shoe box
3. Cardboard 8" x 8"
4. Small green branches from trees

To give the students a concrete experience of erosion have the students to bring in some shoe boxes before the day of the activity and some small green branches from a tree on the day of the activity. Hold a general discussion of erosion and ask questions and solicit comments about erosion.

Read aloud while the students read silently the student sheet. Allow them to answer the questions orally before they begin but do not give them the answer.

After the students have finished the wind erosion activity you may want to involve the students in an outside activity. If it is feasible have a couple of the boys to build a mound of sand. Have another student to pour some water from a flower sprinkler or a can with holes in it over the mound and have the students to observe what happens.

If you have an area around the school where erosion has taken place you may take the students on a field trip and observe what occurred, be sure to bring out the fact that grass prevents some soil erosion. There is a film on erosion in the county library which may help to get this lesson over with the title <u>EROSION</u>.

STUDENT

E - 50

WIND EROSION

Materials for groups of three:

1. Sand, fine
2. Shoe box
3. Cardboard 8" x 8"
4. Small green branches from trees

What is erosion? Erosion is the movement of soil and rock fragments. What are the different types of erosion? The types are wind, water, ice and gravity. Today we are going to explore wind erosion and maybe water erosion. We are going to use fine sand like on the dunes of a beach. You should also have a shoe box. Cut one end of your shoe box out. Spread some sand on the bottom of the box, enough to cover the bottom. Take your piece of cardboard and fan the sand with a gentle motion. Did you see the sand move?____________ Now fan a little harder until some of the sand blows out of the box. Can you think of ways to prevent this erosion?____

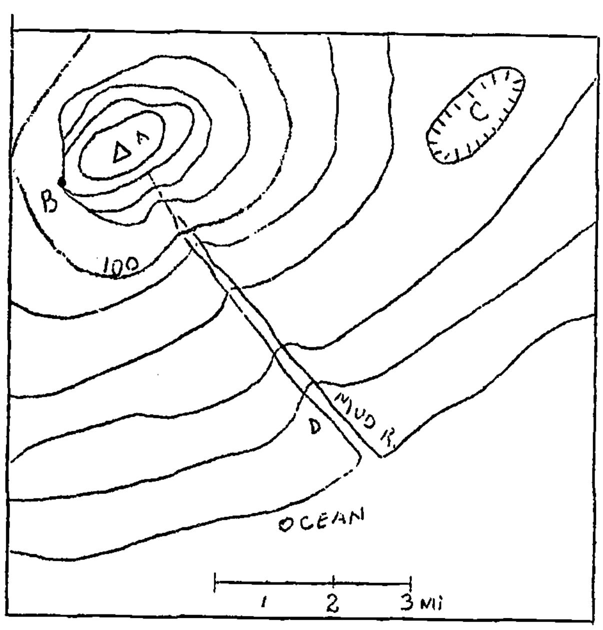
____

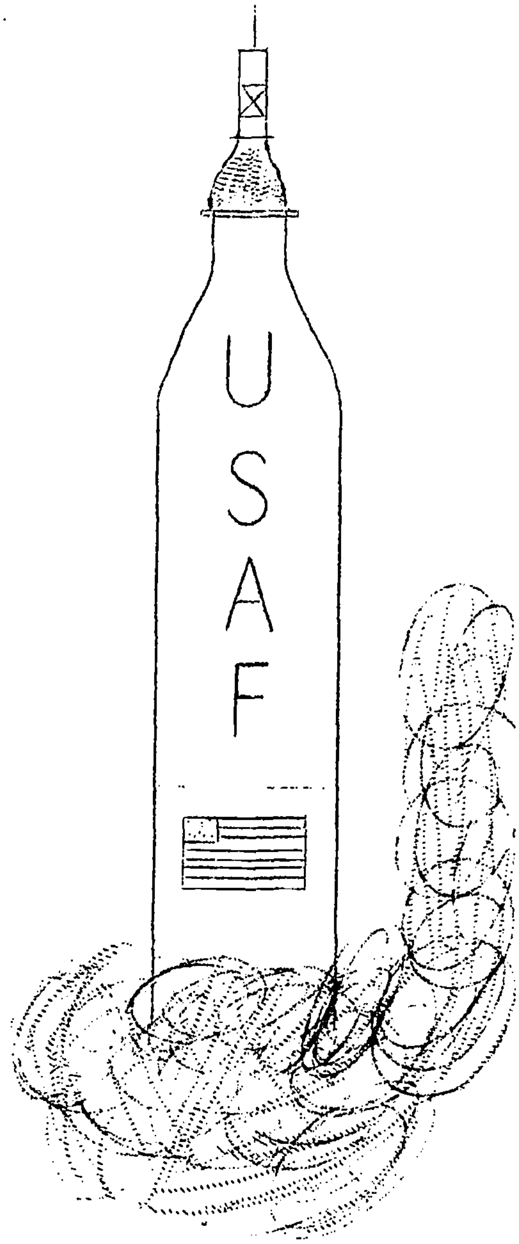
Make a shelter belt by placing the small branches around the edge of the box. Now go through the same procedure as above by fanning. Do you notice less erosion than before?_________________ Sprinkle the sand lightly with water to dampen it. Now fan the sand again as before. Will damp soil erode by wind as easily as dry soil?_________________

When you go home turn your water hose on some soil then turn the hose on an area that has a lot of grass observe what happens to the soil in both cases.

UNIT 8

EARTH AND SPACE





UNIT 8

EARTH AND SPACE

This unit is to introduce the students to some of the phenomena of our heavenly bodies and to answer some of the questions which might have been in the minds of the students concerning these phenomena, but didn't take time to investigate them.

We are going to center most of our activities around the earth, since we are able to observe most of the changes it experiences.

Most of these activities are designed for the students to do with a minimum amount of help.

E-51	WHAT IS THE APPARENT DAILY MOTION OF THE SUN AND THE MOON AND HOW DO WE ACCOUNT FOR IT?
E-52	WHAT IS THE APPARENT SHIFT IN THE MOON'S POSITION FROM DAY TO DAY Film: THIS IS THE MOON: MOON AND HOW IT AFFECTS US
E-53	HOW CAN WE ACCOUNT FOR DAY AND NIGHT Film: WHAT MAKES DAY AND NIGHT
E-54	WHAT ARE THE DIFFERENT PHASES OF THE MOON AND HOW DO WE ACCOUNT FOR THEM?
E-55	WHAT ECLIPSES ARE THERE AND HOW DO WE ACCOUNT FOR THEM? Film: WHAT IS AN ECLIPSE
E-56	WHAT MAKES IT WARMER IN SUMMER THAN WINTER? Film: SEASONS
*E-57	BE WEIGHTLESS - FALL FREE Film: GRAVITY, WEIGHT AND WEIGHTLESSNESS
*E-58	ACTION AND REACTION
E-59	HOW ROCKETS WORK Film: HOW ROCKETS WORK
E-60	FINDING OUR WAY
E-61	SUNKEN TREASURE
E-62	ITEMS BASIC FOR MAPS
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E-64	TOPOGRAPHIC MAPPING
E-65	TOPOGRAPHIC PROFILE
E-66	READING TOPOGRAPHIC MAPS

*READING ACTIVITIES

TEACHER DIRECTION E - 51

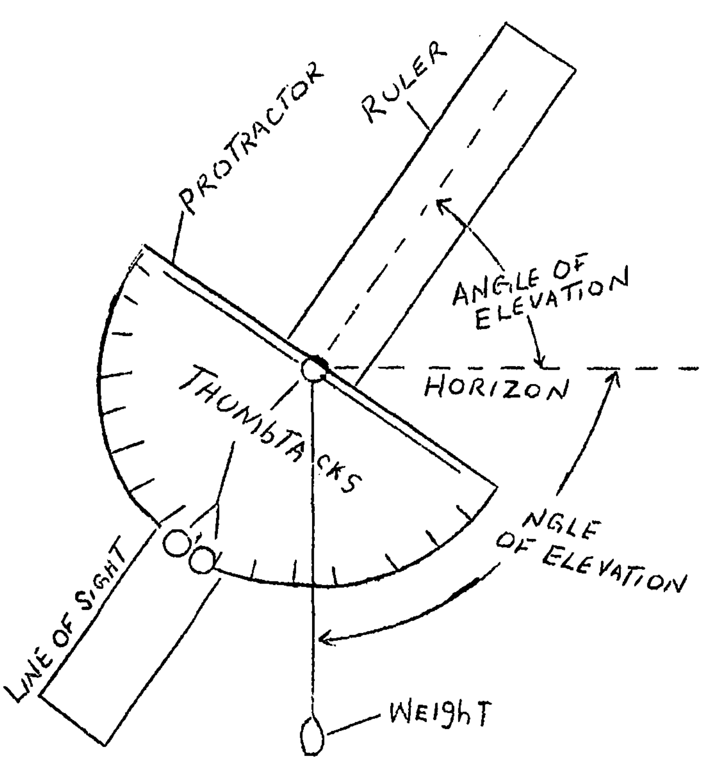
WHAT IS THE APPARENT DAILY MOTION OF THE SUN AND THE MOON AND HOW DO WE ACCOUNT FOR IT?

Materials for groups of three:

1. Compass, magnetic
2. Protractor
3. Ruler, wooden
4. Tacks, thumb (3)
5. Dark film negative
6. Plastic Straw
7. String 8"
8. Weight, small

Before the students begin work on the activities they should construct an astrolabe which serves as a sextant, for determining the altitude of certain celestial objects. Use transparency E-51 to show how to construct the astrolabe.

HAVE THE STUDENTS READ EACH ACTIVITY BEFORE DOING ANY WORK.



STUDENT E - 51

WHAT IS THE APPARENT DAILY MOTION OF THE SUN
AND THE MOON AND HOW DO WE ACCOUNT FOR IT?

Materials for groups of three:

1. Compass, magnetic
2. Protractor
3. Ruler, wooden
4. 3 tacks, thumb
5. Dark film negative (1)
6. 1 plastic straw
7. String (8")
8. Small weight

It is possible to give the approximate location of an object in the sky by giving its compass direction and its altitude. Figure # 1 shows how compass direction might be given. Draw into this figure and label the following direction. Southeast, Southwest, Northwest, South-Southeast and South-Southwest. How many degrees are there between east and north?_________ Measure with your protractor. Between Northeast and south__________________, between northwest and north __________________, between west and southeast ___________, between southeast and south-southeast______________________.

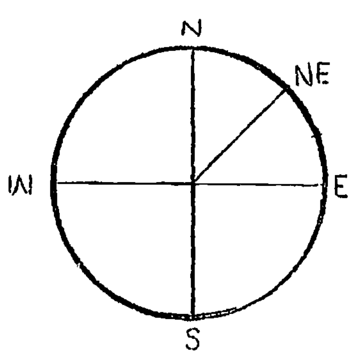


Figure # 1 - Compass direction

As you can see, it is quite easy to locate in a fairly accurate way the horizontal of direction of some object.

Student
page 2

Now, since the heavenly bodies will be some distance above the horizon, you also need to be able to indicate the altitude of the object. Note figure # 2 - Altitude. Consider the horizontal earth's surface as the horizon - zero degrees. As you look straight overhead to the zenith it is 90 degrees altitude. If you make a 45 degree angle with the horizon the altitude of the object would be approximately 45 degrees. Using a ruler, draw in on either side of the zenith line a 30 degree angle altitude, a 60 degree angle altitude, a 15 degree angle altitude, and a 75 degree angle altitude.

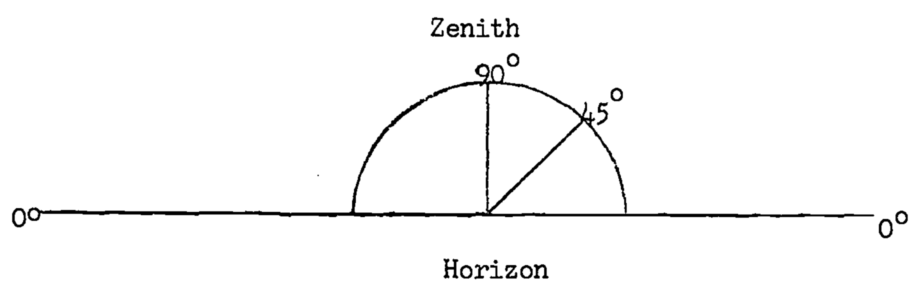


Figure # 2 - Altitude

It should be clear now that it is possible to locate approximately almost any object in the sky by means of compass direction and altitude.

How to use the Astrolabe:

Hold the protractor at eye level and look through the straw letting the weight hang down. Keep the protractor steady and move the ruler so that you can sight an object along it. As you get the ruler lined up on an object, clamp the string to the protractor scale with your thumb. The angle measured by the string is also the altitude of the object viewed.

In small groups from some position in the school yard which your teacher will designate, measure from that spot the altitude of one corner of the school building. With your astrolabe and compass record altitude and direction.

Student
page 3

Do the same with some street light. Record altitude and direction. While looking through a dark film negative at the sun record its altitude, direction, and also the time of day. If the moon is visible in the sky, record its altitude and direction and time of day. In what direction does the sun rise?________________ What is its altitude and direction at noon?________________ In what direction does the sun set?____________ Does the sun rise in one direction, move across the sky, and set in the opposite direction?__________ If so, it moves from __________ direction to ____________ direction. In what direction does the moon move across the sky?________________

Question:

1. How can you account for this apparent motion of the moon and the sun across the sky?

TEACHER DIRECTION E - 52

What is the apparent shift in the moon's position from day to day?

The students will be able to do this activity quite easily, but you should encourage them to make accurate observations at the same time. You may consult an almanac or a calendar to find out when to start their observations, you should start when the moon is in one of its major phases.

The students will need to work on activity E-52 over a period of 10 days. Allow the students to carry their compasses and astrolabes home each night, letting a different person in each group gather the data from his observations so that each person will have at least two opportunities. Each student should record the data gathered by their group members. Check the student's observations each day before going on with the other activities.

STUDENT E - 52

WHAT IS THE APPARENT SHIFT IN THE MOON'S POSITION FROM DAY TO DAY AND HOW DO WE ACCOUNT FOR IT?

You will need your astrolabe and a magnetic compass to make observations of the moon's direction and altitude on several successive days or nights, perhaps through a period of 10 days. Fill the table of observations as marked on this sheet. Also, sketch the shape of the moon as you are making the observations for use in a later activity.

TABLE OF OBSERVATIONS

Days	Date	Hour	Direction	Altitude	Shape
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

If we compare the position of the moon on successive days, does it shift its position?_______________ If so, in what direction?_______________ Could we account for this apparent motion by having the earth rotate on its axis from west to east?_______________ Could we account for it by having the moon revolve around the earth from west to east?_______________

STUDENT E - 53

HOW CAN WE ACCOUNT FOR DAY AND NIGHT?

Materials for groups of three:

1. 1 large styrofoam ball or rubber ball (5 inches)
2. 1 flashlight

You have seen that the sun apparently rises in the east, moves across the sky during the day and sets in the west at evening time. It is light during the time when the sun is moving across the sky and it becomes dark after the sun has settled below the horizon. Man used to think that day and night were caused by the sun going around the earth.

Scientists today believe that day and night are caused by the earth rotating on its axis. Can you account for day and night in this way?

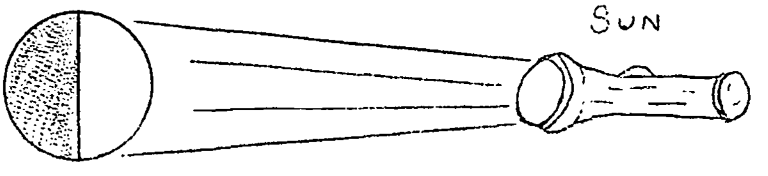
In groups of three see if you can represent how day and night might be caused by the sun going around the earth. Have one student hold the ball which represents the earth while another student walks around the "earth" with a lighted flashlight focused on the ball. Have the third student watch the ball carefully and see if the part lighted by the flashlight moves around the earth from east to west. If we had no way of knowing if the earth rotated on its axis, could we account for day and night by having the sun go daily around the earth from east to west.

To see if we account for day and night by having the earth spin on its axis, have one student spin the ball representing the earth in a counterclockwise direction while another student focuses the flashlight on the ball. Does the lighted portion of the "earth" move from east to west? Can we account for day and night by assuming that the earth spins on its axis from west to east?

Student
page 2

From the above experiments which of the two models is correct? If not, what other factors should one consider trying to account for day and night?

Ball representing the earth.



TEACHER RESOURCE

The **phases** of the moon have been used since the beginning of history to measure time since the period from new moon to new moon is a natural unit to measure lengths of time less than a year.

As the moon revolves around the earth, its orbit takes it first between the sun and the earth and then to the other side os the earth away from the sun. The moon seldom passes directly between the sun and earth because its orbit is tilted about 5° from the plane of the earth's orbit around the sun. When the moon is in the area between the earth and sun, the side of the moon toward us is not lighted directly by the sun. Still, the moon is faintly visible because of sunlight reflected by the earth. This light is called earthshine. During one apparent revolution around the earth ($29\frac{1}{2}$ days) the moon pases through all of its phases.

The moon always keeps the same side turned toward the earth. In order to do this, it must rotate on its axis in about the same period of time in which it revolves around the earth. Since its actual period of revolution is 27 1/3 days, its period of rotation must be approximately the same number of days.

The moon rises about 50 minutes later each day. The moon is moving in its orbit in the same direction as the earth rotates (from west ot east), therefore, the earth takes a little longer each day to turn around far enough to make the moon visible in its new position farther along in its orbit.

STUDENT

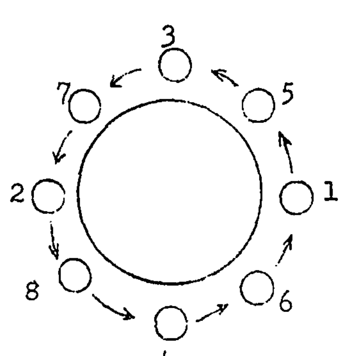
E - 54

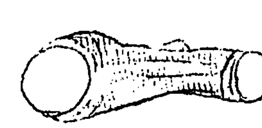
WHAT ARE THE DIFFERENT PHASES OF THE MOON AND HOW DO WE ACCOUNT FOR THEM?

Materials for groups of three:

1. 1 styrofoam or rubber ball (about 5 inches)
2. 1 piece of wire (about 10 inches long) for a support
3. 1 flashlight

The above materials can be used to represent a model of the sun- moon-earth system. Stick a wire into the ball to hold it easily. Let the ball represent the moon and the flashlight represent the sun. The person holding the ball will represent the earth. While one person keeps the flashlight focused on the moon, have the (earth) student holding the ball turn around in a counter-clockwise direction while holding the (moon) at arm's length. Start with the (moon) directly in front of the (sun). The person representing the earth should see the various phases on the (moon) as he moves around in a counter-clockwise direction. Identify the position of the "moon" when it appears as a new crescent or a new moon. As a first quarter moon. As a new gibbous moon. As a full moon. As an old gibbous moon. As a last quarter moon. As an old crescent.





Using the above diagram, observe and record your observations of the moon's position # 3 - #8

Student
page 2

Question:

1. Match the correct phases with the correct positions using the diagram on page 1.

Phases	Positions
a. New	______
b. New Crescent * (waxing)	______
c. First Quarter	______
d. New Gibbous (waxing)	______
e. Full	______
f. Old Gibbous *(waning)	______
g. Last Quarter	______
h. Old Crescent (waning)	______

2. When holding the flashlight, did you observe any phases?______________

3. In what direction does the moon revolve?____________________________

4. Draw your own diagram showing the sun - earth - moon relationship, Sketch and label each phase in their proper positions. (Hint: Diagram in the activity section may help.)

5. Using your own diagram, answer the following questions.

   a. If it takes about 14 days from new moon to full moon, then how many days does it take to go from full moon to new moon?_____________________

   b. How many days is it from first quarter phase to last quarter phase?__________

   c. Historically, the word month comes from a complete phase change of the moon, such as from new moon to new moon. How many days does this take?

   ____

   6. What would happen if the moon was exactly between the earth and the sun or the earth exactly between the moon and the sun?_____________________

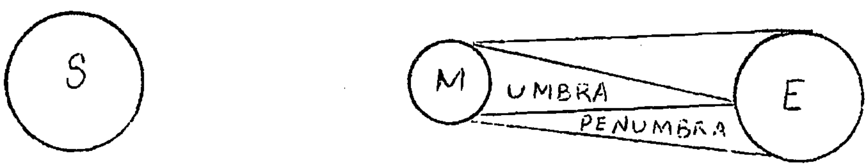
* Waxing - the visible portion is increasing

Waning - the visible portion is decreasing

TEACHER RESOURCE

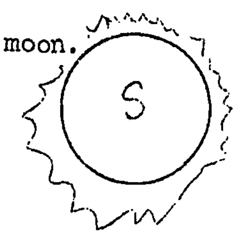
SOLAR ECLIPSE

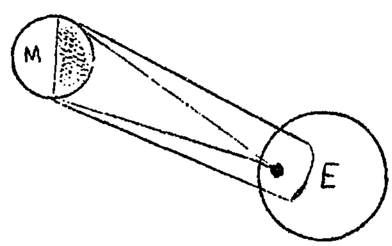
An eclipse of the sun can occur only when the moon is new - when it is between the earth and the sun.



ANNULAR ECLIPSE

The distance from the earth to the moon varies. When an eclipse occurs and the moon is its average distance away or farther, the umbra of the moon's shadow does not reach the earth. An annulus, or thin ring of sunlight remains around the moon.

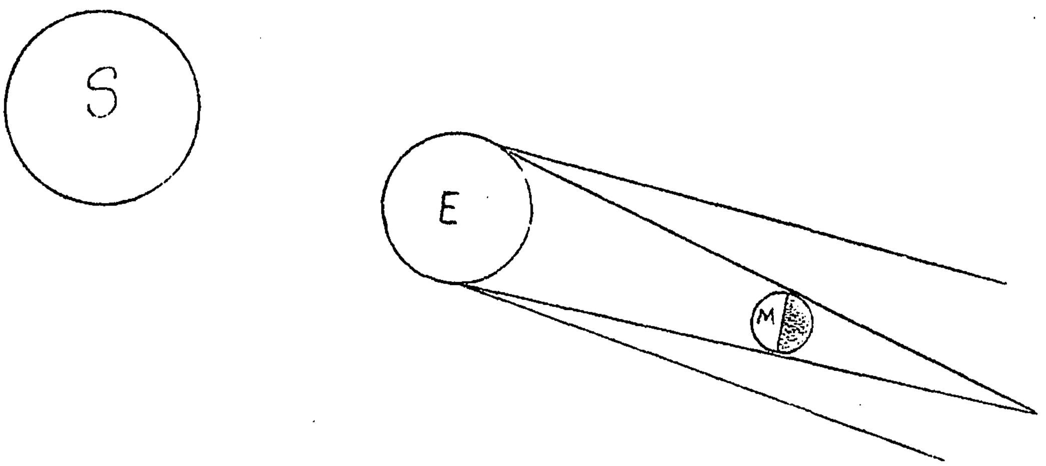




Teacher Resource
page 2

LUNAR ECLIPSE

The earth's shadow is some 900,000 miles long. When the moon enters into it and is eclipsed, the eclipse lasts as long as several hours and may be total for as much as 1 hour and 40 minutes. Though there are fewer eclipses of the moon than of the sun, they last longer and can be seen by more people over a wider area. An eclipse of the moon occurs only at the time of full moon.



For further information consult the Golden Nature Guide - Stars by Zim and Baker

STUDENT

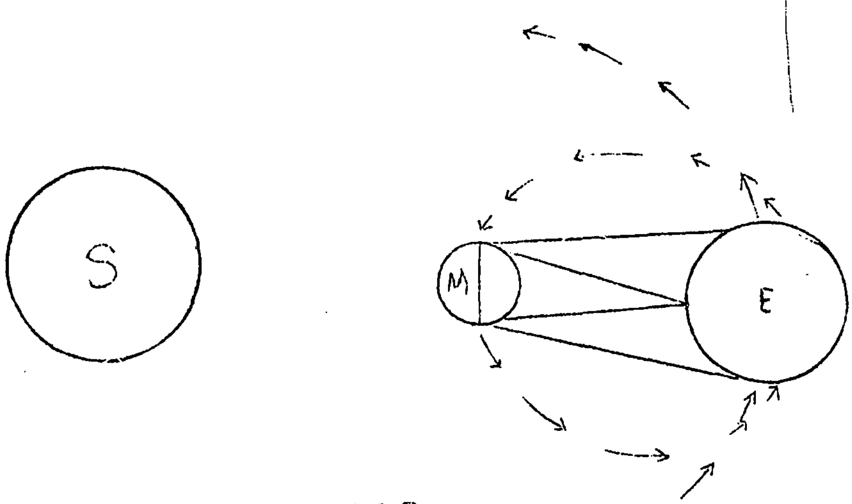
E - 55

WHAT ECLIPSES ARE THERE AND HOW DO WE ACCOUNT FOR THEM?

Materials for groups of three:

1. 1 rubber or styrofoam ball (5" in diameter)
2. 1 tennis ball
3. 1 flashlight
4. 1 white carboard screen (about $8\frac{1}{2}$ x 11 inches)
5. Small screen with $\frac{1}{2}$ inch hole

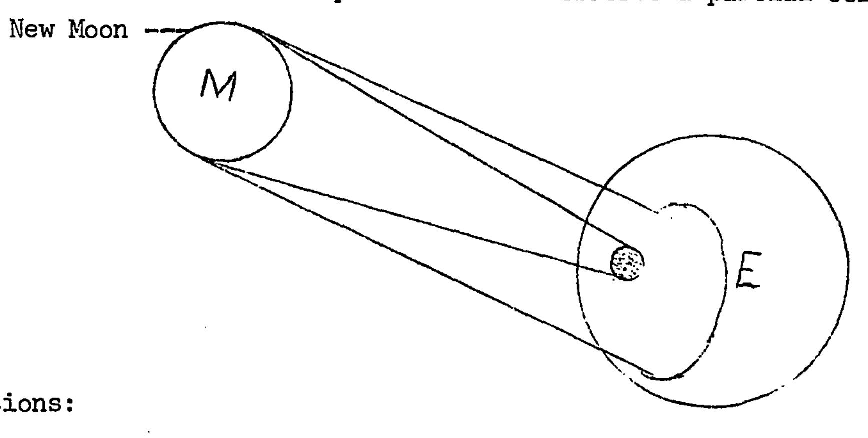
Each of you have noticed your own shadow or that of buildings or telegraph poles or other things. How are the shadows cast? Is it because something comes between the sunlight and the place where you are looking? Occasionally, it happens that the moon is in such a position that it completely blocks out the sunlight from the place where you may be living. More often it happens that the earth's shadow stops sunlight reaching the moon and we have an eclipse of the moon. We can account for these eclipses if we assume that the moon goes around the earth as shown in the figure below. Then, when the moon comes between the sun and the earth, in a direct line its shadow could fall on the earth and when the moon is behind the earth, the earth's shadow could fall on the moon. Try this using the styrofoan ball as the earth, the tennis ball as the moon and the flashlight as the sun.



Student
page 2

Experiment with the flashlight and the screen by making shadow pictures with your hands and various objects and noticing the shadows that are cast on the screen by these objects. Are the shadows sharp or are they fuzzy? In this instance, you've had light coming directly from the bulb of the flashlight. and also from the reflector of the flashlight. Now try placing a small screen with a hole right in front of the bulb but blotting out the light from the reflector of the flashlight making it a point source of light. Now are your shadows sharp or are they fuzzy?

Since the sun is much larger than the moon, the shadows you should get with this apparatus should correspond more to the first instance above then the second instance. The diagram below shows the totally dark shadow called the umbra surrounded by the partially dark area called the penumbra. A person on the earth in the umbra would witness a total eclipse of the sun while the person on the earth in the penumbra would observe a partial eclipse of the sun.



Questions:

1. How does the size of the light scource affect the sharpness of the shadows?

2. How does the distance of the object from the light source affect the size of the shadow?

Student
page 3

3. How does the distance between the "earth" or "moon" affect the size of the shadow cast?

4. Will an eclipse of the sun occur at the time of the new moon or the full moon?

5. Will an eclipse of the moon occur at the time of the new moon or the full moon?

6. Draw diagrams showing an eclipse of the moon and sun and label the parts:

STUDENT RESOURCE

The imaginary line through the center of the earth from the northpole to the southpole is called the earth's axis. The curved path of the earth around the sun is called the earth's orbit. As the earth travels around in its orbit, its axis is always tilted 23.5 degrees. In June the north half of the earth is tilted toward the sun, and the south half is tilted away from the sun. In June, this tilt of the earth's axis causes the sun's rays to fall more directly, or vertically, on the northern hemisphere, and less vertically or slanted on the southern hemisphere. As a result, the June days are both longer and warmer in the northern hemisphere than in the southern hemisphere. In June, then, the northern hemisphere is having summer while the southern hemisphere is having winter.

In December, the earth is on the opposite side of its orbit. The north half is tilted away from the sun, and the south half is tilted toward the sun. This makes December days colder and shorter in the northern hemisphere.

TEACHER DIRECTION E - 56

WHAT MAKES IT WARMER IN SUMMER THAN WINTER

Materials for groups of three:

1. 2 thermometers
2. Black construction paper (2)
3. Light source (high intensity)

Teacher materials

1. Filmstrip projector
2. Globe

Before the students do activity E-56 hold a general discussion on how the seasons changes. Use a globe and projector lamp to illustrate the tilt, the axis, the rotation and revolution of the earth. Be sure to bring out the fact that the earth makes $365\frac{1}{4}$ turns during its trip around the sun. You might have the students to calculate the number of trips around the sun they have made since they were born. Use several stud nts to help in your demonstrations. Solicit answers to your questions.

After spending sometime on the demonstration and discussion, inform the students that this activity is to show the effects of sun rays in determining the seasons.

WHAT MAKES IT WARMER IN SUMMER THAN IN WINTER

Materials for groups of three:

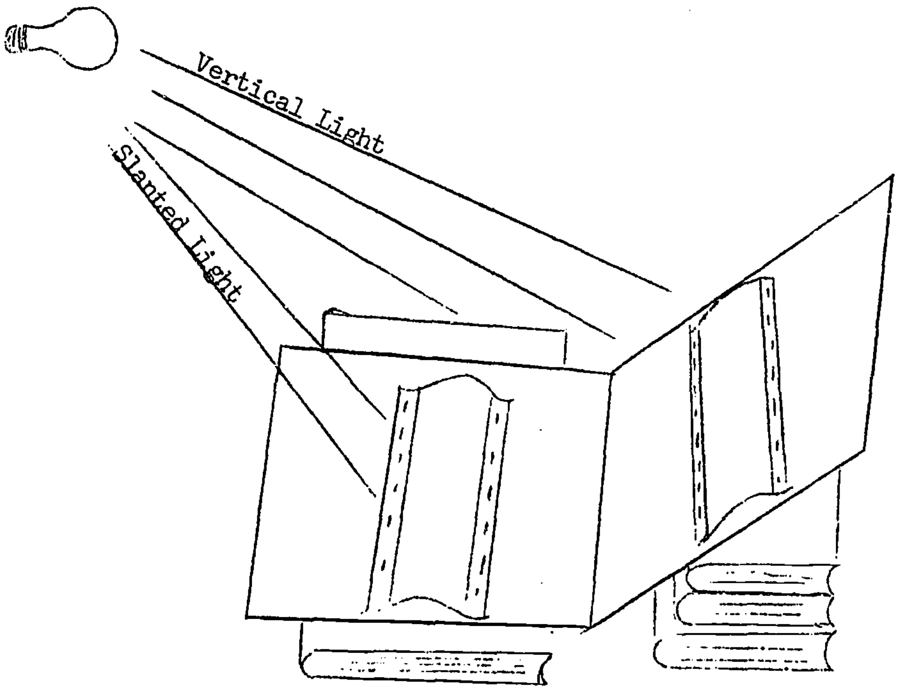
1. 2 thermometers 2. 2 black construction paper 3. Light source

Each of us know that it is much warmer in the summer than it is in the winter. But, why is this? Let's think about the summer time and about the winter time. How do the lengths of the daylight hours compare in the summer time with the lengths of the daylight hours in the winter time? You will recall that each summer we go on daylight saving time, setting our clocks ahead so we will have more daylight hours for recreation in the afternoon. Then, each fall we set our clocks back to standard time so we won't have to get up so much before daylight. In other words, there are more hours of sunshine each day during the summer than during the winter and one reason that it is warmer in summer then in winter is that there are more hours of sunshine per day.

How about the intensity of the sunlight in the summer compared to the winter time. Are you warmed as much when you go out in the sunlight in winter as you are in summer? Supposing you went out at noontime; is the sun as high in the sky in winter as it is in summer? In summer, it is almost directly overhead, is it? not? While in winter it may be at an altitude of from 45 to 60 degrees at noon. Will the sunshine be more intense if the rays strike us from nearly overhead or if they strike us slanted as in the winter time. To test this fold a sheet of black paper in half, fasten a smaller piece of black paper to each half, to make a pocket. Place the paper on top of, and leaning against some books as shown in the diagram. As the diagram shows, half of the paper is getting the light straight down on it. We say it is getting vertical light. What does the word "vertical" mean?__________________________ The other half is getting light at a "slant" (angle).

Now slip a thermometer in each pocket. After 15 minutes take the thermometer s and read them. Which part is warmer?____________________________________

Student
page 2



TEACHER DIRECTION E - 57

BE WEIGHTLESS--FALL FREE

This is a reading activity to help increase the students reading comprehension. Have the students read the activity before doing the exercise. After they have finished hold a general discussion of the activity.

The film Gravity, Weight and Weightlessness, maybe shown for more effective comprehension.

STUDENT E - 57

BE WEIGHTLESS - FALL FREE

How much do you weigh? Whatever your weight is here on earth, you would weigh much less on the moon. But if you take a spaceship to Jupiter, you would weigh more than twice as much there as you do on the earth. Add on the trip through space, you would weigh nothing!

However, the same clothes would fit you anywhere. Your size would stay the same.

How can these facts be true?

Your weight on the earth depends on a force called gravity. This is the force that pulls objects toward the earth. Weight is a measure of the force of gravity. Your weight on the moon would depend on the force with which the moon's gravity pulls you.

The moon's mass is less than that of the earth. So, the force that would pull, or attract, you to the moon is less than the force attracting you to the earth. The moon's pull is only one sixth as much as the earth's pull.

The list below compares the pull of eight bodies. To find your weight on each body, multiply your weight on earth by the number shown. For example, if you weigh 85 pounds and want to know what you would weigh on Mercury, multiply 85 by .36.

Earth 1.00	Mars 0.38	Mercury 0.36	Saturn 1.13
Moon 0.16	Jupiter 2.64	Venus 0.87	Sun 27.90

Let's see how much you would weigh on each of these bodies.

Earth ________ Mars ________ Mercury ________ Saturn________

Moon ________ Jupiter ________ Venus ________ Sun ________

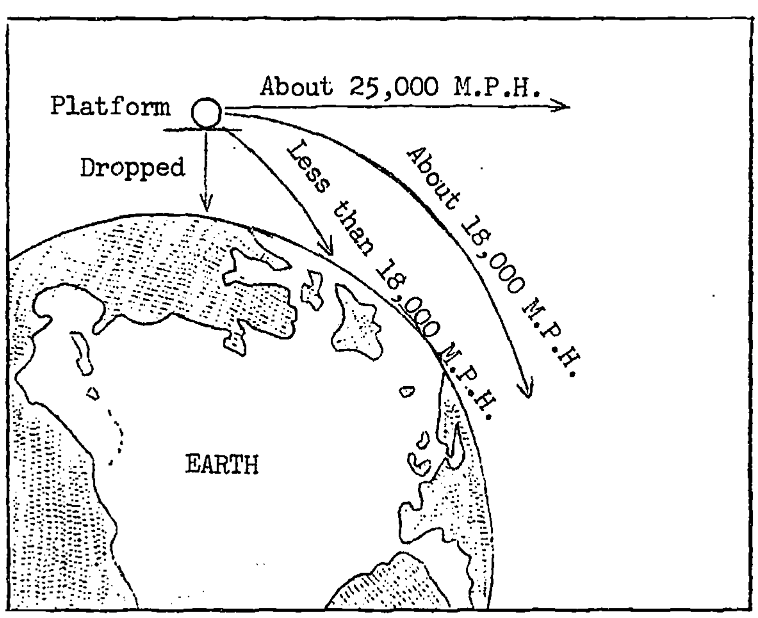
Student
page 2

Sitting in a chair, you feel your weight press down on the seat. The chair keeps you from falling to the floor. When you step on a scale, its platform keeps you from falling farther downward. The scale measures the force with which you press down on the platform.

Jumping off a high step, you fall downward. You feel no weight during the moment you are in the air. You feel weight only when you landed and pressed down on the earth.

But suppose you were falling through space without landing on earth or another planet. You would stay weightless so long as you went on falling.

That's what happens in a spaceship in orbit around the earth. The ship, the pilot and the chair he sits in fall together around the earth. Their fall is caused by the force of gravity. The pilot does not feel himself press down on his chair because it is falling at the same rate as he is.



To understand that orbiting is falling, think of a ball on a platform 50 miles above the earth. If you dropped the ball, it would fall in a straight

Student
page 3

toward the center of the earth. If you threw the ball eastward at a speed of 100 feet a second, it would travel to the earth in a curved path.

If you could throw it fast enough - nearly five miles in a second - its curved path would exactly match the curve of the earth's surface. It would still be falling and weightless, but its fall would not bring it nearer the earth. The ball would be in orbit.

A spaceship goes into orbit around the earth when its rockets get it moving about 18,000 miles an hour. At that speed, the ship falls in a curve matching the curve of the earth.

In the ship, the pilot does not have the sense of "down" and "up" that we have because we are held to the earth by gravity. He is weightless. Astronauts must learn to get used to this strange feeling and to do their work in spite of it.

TEACHER DIRECTION E - 58

ACTION AND REACTION

Materials for groups of three:

1. Roller Skates
2. Basketball

This reading activity is designed to help the students understand the principle behind rocket engines. The students may or may not have heard of Newton's Laws of Motion, it is almost imperative to mention something about one of them.

Have one or two of your students bring a pair of roller skates and a basketball. After having the students read over the activity once or twice read the activity aloud while they read it silently to insure comprehension. When you finish the reading have one student put on the roller skates and toss the ball to another person. Discuss what happened and bring out the fact that this principle is used in rocket engines.

STUDENT E - 58

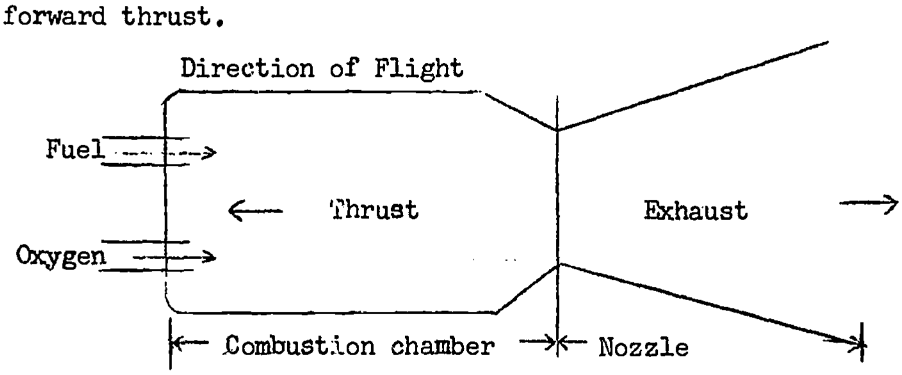
ACTION AND REACTION

Some people learn about action and reaction the hard way. If you step toward a dock from a canoe, the foot still on the canoe pushes it away from the dock. Even if the dock were not there at all, the canoe would move in the same way when acted upon by the same force. Whenever one body exerts a force on a second body, the second exerts an equal and opposite force on the first. In other words, FOR EVERY ACTION THERE IS AN EQUAL AND OPPOSITE REACTION.

Many accidents have happened to people who were standing up in a vehicle that suddenly started forward. The first body (vehicle) exerted a force on the second body (person standing up), but this force causes the person to fall in the opposite direction.

When you walk along the floor, you exert a backward force on the floor. The floor exerts an opposite force which pushes you forward. The propeller of an airplane exerts a backward force on the air through which it moves and is there by given a forward thrust. But how does a space rocket push itself forward where there is no air to push against?

The space rocket pushes against its own fuel which it forces out in the opposite direction. The greater the speed of the exhaust gases, the greater the forward thrust.



(The thrust of a rocket is produced by the expansion of gases in the combustion chamber of the rocket engine).

TEACHER DIRECTION E - 59

HOW ROCKETS WORK

Materials for groups of three

1. Balloon, vertical
2. Wire 5'
3. 2 plastic straws (2")
4. Pinch cock clamp or clothespin
5. 2 chairs
6. Transparent tape

The purpose of this activity is to reinforce the idea that a rocket engine works on the action - reaction principle.

Using transparent tape, the students can attach 2 inch pieces of a drinking straw to the side of a long balloon. Then they should pass a thin wire through the straw and attach one end of the wire to a chair. Next they should pull the wire tight and attach the other end to another chair on the opposite side of the room. After inflating the balloon the students should release it suddenly. Let the students observe the baloon's movement in reaction to the direction of the escaping air.

Explain that this is what is meant by action and reaction. The action of the air rushing out one end of the balloon causes a reaction, or movement, in the opposite direction.

STUDENT

E - 59

HOW ROCKETS WORK

Materials for groups of three:

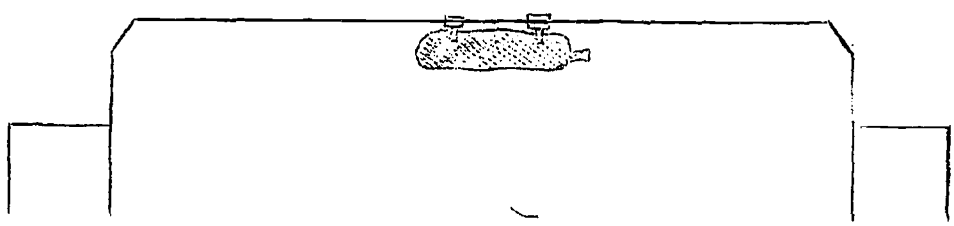
1. Balloon, vertical
2. Wire 5'
3. 2 plastic straws (2")
4. Pinch cock clamp or clothespin
5. 2 chairs
6. Transparent tape

We know rockets are used to put us in orbit around the earth and in order to escape the earth's gravitational pull we have to reach a speed of 25,000 miles per hour, (escape velocity). But how does the rocket take off? Let's see if we can find out by using some simple materials.

Your teacher will pass each group the materials needed.

Tie one end of your wire to the first chair. Now slide your two straws onto the wire, then tie the wire to the second chair. One student will blow up the balloon and put a pinch clamp on the neck of the balloon while the others are attaching two strips of tape across the straw so that the tape is overlapping on both sides of the straw.

Now attach the balloon to the tape as shown in the diagram below. When you have finished setting up your model release the clamp from the balloon and observe what happens.



1. Did the balloon move along the wire?______________________________
2. If yes, what caused the balloon to move along the wire?______________________________

____

TEACHER DIRECTION

E - 60

FINDING OUR WAY

Materials for groups of three:

1. Cardboard (9" x 22")   2. Scissors   3. Magnetic compass

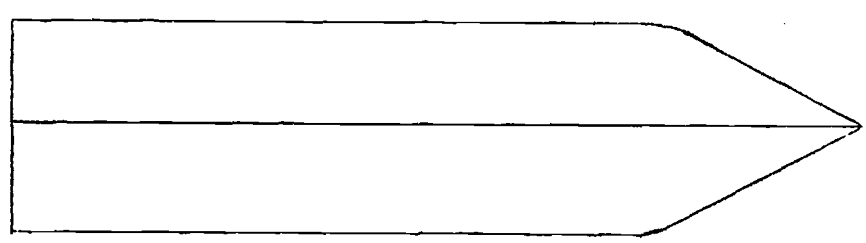
This activity is designed to teach the students the basic science of navigation and a few of the common terms of the sea. Boating is a rapidly growing sport for pleasure-seekers and also a growing service industry requiring more and more people to fill the new jobs. After this activity, the students should be acquainted with the function and use of the compass, the nautical mile, fathom, and the conversion of land measures to sea measures.

A marine compass probably will not be available, so the activities will be written for use with a standard land compass. The only change to be made if marine compasses are available is to simplify the procedure for staying on course.

HOW MANY OF YOU HAVE EVER BEEN FISHING? HOW MANY OF YOU HAVE EVER BEEN FISHING IN THE OCEAN? IF YOU CAN'T SEE ANYTHING BUT WATER, HOW DO YOU KNOW HOW TO GET BACK TO SHORE? Use a compass. WHAT IS A COMPASS? HOW DOES IT WORK? Use transparency E-60 to discuss the compass. Emphasize the degree markings

LET'S TAKE A BOAT TRIP OUT IN THE OCEAN. OF COURSE, WE CAN"T REALLY GO OUT, BUT WE CAN PRACTICE OUR NAVIGATION. WE NEED A BOAT -- LET'S BUILD ONE.

Cut out a boat from a piece of cardboard (one for each group of three students) It should be large, about 22 inches long and 9 inches wide. Draw a line down the length of the boat.



Pass out E-60

Teacher Direction
page 2

NOW WE HAVE A BOAT AND COMPASS, LET'S FIND OUT HOW TO NAVIGATE. PLACE YOUR COMPASS ON THE BOAT ON THE CENTER LINE. POINT YOUR BOAT NORTH. THIS WILL BE 0° AND ALSO 360°. NOW, SUPPOSE YOU WANTED TO TRAVEL ON A 60° BEARING. WHERE IS 60° ON THE COMPASS? Pause. TURN YOUR BOAT SO THAT YOU WOULD BE ON 60°. Pause. LET'S TRY IT THIS WAY. KEEPING THE COMPASS NEEDLE ON NORTH, TURN THE BOAT UNTIL THE CENTERLINE IS ON 60°. AS LONG AS WE KEEP THE NEEDLE ON NORTH, THE BOAT WILL POINT 60°, UNLESS WE ROTATE THE BOAT AGAIN. Pause, discussion.

After all seems to understand how to nagivate, go outside to the "docks" and embark on a boat trip. They should end up at the "docks" if they follow directions. The directions will be given in nautical terms, so use the following conversion.

1 Nautical mile	=1 step
1 Fathom	=1 inch
1 Knot	=1 step per second

Help each group get started on their first course, 135°, then let them go. After the "cruise" return to the classroom and plot the course on paper. One-half inch to the mile is a good scale.

As a final activity for the next day, bury a slip of paper eight fathoms deep and plot a course using standardized steps and accurate measurements. The first group to find the paper gets a prize, perhaps a round of cokes.

STUDENT E - 60

FINDING OUR WAYS

Materials for groups of three:

1. Cardboard (9" x 22") 2. Scissors 3. Magnetic Compass

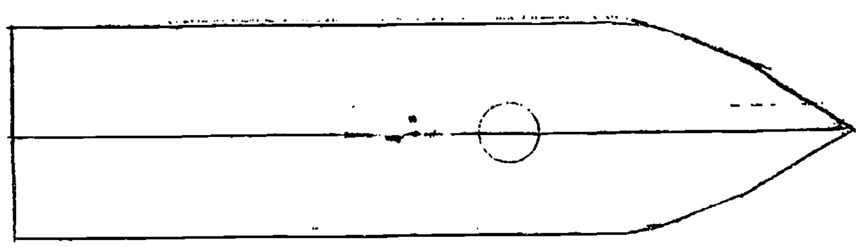
You have heard the word "navigation" many times. It really doesn't mean much to you beyond finding your way. The big question is HOW? In a car, you read signs and use a road map to direct you down the right road. But if you don't have a road map or a road or signs, what do you do? We pull a Daniel Boone and use a magnetic compass.

You all know what a compass is, just a magnet in a case. The magnet is pointed and the painted point always points to the north magnetic pole which here in Florida is close to the north pole. If we know which way north is, then we know all the other directions, also.

Take your compass and look at the bottom of the case. Turn the case until the needle points North. Notice the other letters; turn the compass case and notice that the needle doesn't turn, it always points North.

You will be charting your course in degrees. The degrees scale is located around the upper edge of the compass case. Now, let's take a cruise.

Take a piece of cardboard and cut it out in the shape of a boat. Make it about 9" wide and 22" long.



Draw a line down the center of the boat to use as a reference line. Place your compass on the center of the boat and point it to the North. The N should be under the painted tip. Now, hold the compass still and rotate the boat until it points toward 135° (SE). The line on the boat should pass through 135° and

Student
page 2

315°. As long as you hold the needle on 0° (N), the boat will point towards the 135° course.

1 nautical mile = 1 step

The course:

135° for 24 nautical miles (steps)

then 180° for 10 nautical miles

then 315° for 24 nautical miles

then 360° for 10 nautical miles

You should end up the same place you started. If not, try it again with another navigator. When you have finished, go back to your room and draw a chart of your cruise. Use a scale of $\frac{1}{2}$" equals 1 mile.

STUDENT E - 61

SUNKEN TREASURE

See if you can find the sunken treasure. Use your boat and compass to the exact spot and dig up the ....

Proceed on a course of 90° from the dock for 20 nautical miles. Ask your instructor for the exact length of the nautical mile (her step length). Turn to a course of 120° and sail 30 nautical miles, Turn to a course of 270° and proceed 30 miles. Now take a course of 300° and sail 20 miles. Then come about to 325° and proceed 10 miles. Send a diver down (dig) for about 5 fathoms (inches) and find the treasure. If you miss, start over.

TEACHER RESOURCE

MAPS AND MAP READING

Maps are used to find out many kinds of information about the earth's surface. To understand any map, we must first know its relation to the compass directions. The standard method of showing compass directions on a map is to make the top of the map north. Because of the magnetic declination, compass direction does not usually agree with true north as shown by the meridians. In order to change compass direction at a certain location into true direction for the same location, you will have to look up the declination. On small maps, the declination for a particular area can be given on the map. It maybe printed below the map or indicated as a symbol on the map itself.

Once a person has determined directions the map user is generally interested in distances. All maps must have some basis for comparison between actual distances. All maps must have some basis for comparison between actual distance on the earth and the same distance measured on the map. This relationship is the scale of the map. The scales maybe graphic (0 ½ 1 Mile) fractional, (1/10,000) or verbal (one inch equals one mile).

Most maps will have a legend showing symbols which represents certain features on the map.

There are many types of maps geologic maps, topographic maps, road maps, weather and climate maps, etc. In this unit we will work with some of these maps.

Topic - 1 A map is defined as the representation of all or part of the earth's surface on a plane.

This part of our unit is designed to increase the ability of the students to understand the general features of maps and their interpretation.

TEACHER DIRECTION E - 62

ITEMS BASIC FOR MAPS

Materials for groups of three:

1. Map of the city
2. U. S. Map
3. ruler
4. Marker, transparency

In this activity we will try to orient the students to the basic items used in interpreting maps. Have the students bring to class some road maps obtained from a service station. Hold a general discussion of maps. Asking questions and soliciting answers from the students.

HOW MANY TYPES OF MAPS CAN YOU THINK OF AND WHAT INFORMATION DO THEY GIVE? Discussion. Write the types of maps and information on an acetate. WHAT IS THE FIRST ITEM YOU LOOK FOR ON A MAP? (Compass direction) Discussion. WHAT ARE THOSE LINES DRAWN FROM TOP TO BOTTOM AND SIDE TO SIDE CALLED? Longitudinal or meridians and Latitudinal or parallels. Discussion. Include in the discussion which lines uses certain directions. SOME MAPS HAVE SOMETHING CALLED A LEGEND, WHAT DO YOU SUPPOSE A LEGEND IS AND WHAT DOES IT CONTAIN? An area on a map that gives information concerning the features on the map. Discussion. Discuss the types of scales used on maps.

Let's see if we can interpret a road map and a U.S. map. Have the students to find the compass direction,* next have them indicate what type of scale is being used. (graphic, fractional or verbal) To help orient the students in finding their way from one point to another and the mileage. Designate a starting point and an ending point on the city map. Let the students draw lines indicating the path taken and the approximate number of miles to the scale.** See how many took the shortest route, Give a small prize for the shortest distance taken.

Talk about the symbols used on the map, after which you will give the students

Teacher Direction
page 2

a different starting and ending point for them to plot on a U.S. map. But have them to write in all of the details they encountered, i.e. roads under construction, highway directions traveled, mileage, etc.

* If the maps the students have give only north, east, south and west be sure they include NW SW NE & SE

** Inform the students to mark off the required distance on the straight edge of a sheet of paper and compare with the graphic scale. Zig zag paths should be be marked off on the paper edge as a series or succession of straight paths

STUDENT

E-- 62

ITEMS BASIC FOR MAPS

Materials for groups of three:

1. Map of the city
2. U. S. map
3. Ruler
4. Marker

If you needed to find out where a place is or how to get there you would use a map, but before getting the map you should know how to interpret the information given on a map. Obtain a city map.

First locate the compass direction. Next look over the legend, the legend will give you the scale and symbols used to show certain features on the map. What type of scale is used on your map?______________________________

Your teacher will give you a starting point and an ending point on your city map. See if you can come up with the shortest number of miles between the two points using your scale to convert the inches to miles. Draw a line with your marker to show the path you took. There will be a prize for the group with the shortest distance taken.

With your next starting and ending point given by your teacher write out your route taken on your U.S. map giving all the features encountered (highways - interstate, state, direction traveled, street names, mileage, etc.)

TEACHER RESOURCE

To the earth scientists, the most important features on a map are the landforms that shape the earth's surface. All the details that make up the surface features of the land are called its topography. A map made especially to show these details is known as a topographic map. Natural features such as hills, valleys, lakes, plains and streams are the most important details shown on these maps. Artificial features such as buildings, bridges, railroads and roads may also be shown.

The making of these maps are slow and difficult. Survey crews will establish points of known position and elevation height above sea level. These points are used, with high altitude photographs, to make the final map.

All features shown on maps must be indicated by the use of symbols to represent the actual object. Most topographic maps make use of several colors to show various features.

The features of the earth's surface that are most difficult to show on a map is its relief - the difference in elevation. To show variation in elevation of the surface some maps employ hachures to show mountains and hills. These are short straight lines. Draw in the direction that water would take in flowing down the slopes. The most commonly used method to show variations in elevation is by means of contour lines - lines joining points of equal elevation. The differences in elevation between neighboring lines is called the contour interval.

Topographic or contour map - A map which shows the shape and form of the land surface

Elevation - Height above sea level

Contour lines - Lines joining points of equal elevation.

Contour interval - The difference in elevation between neighboring lines.

Hachures (Hash - Yooz) - Lines indicating a slope.

River Valley - Contours bend up stream in crossing a valley.

The contour interval can be determined by dividing the elevation difference between two marked contour lines by the number of intervals between them. Also it may be written in the legend.

Flat or gently sloping land - Widely spaced contour lines.

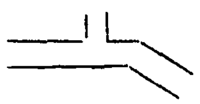
Hill tops - closed circles or ovals.

Depressions have the same elevation as the closest lower contour line.

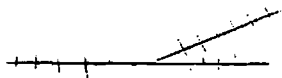
The maximum elevation of a hill, if not given, is one (1) less than the next elevation if the contour line was drawn in.

Student
page 2

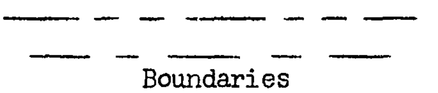
Contour Map Symbol



Road or Highway

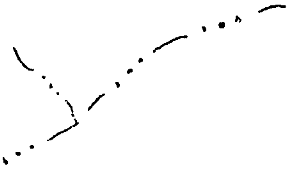


Railroad

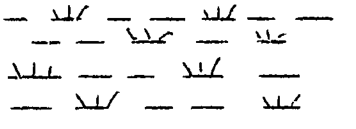


Boundaries

River or Stream

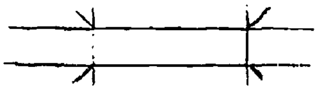


Intermittent Stream

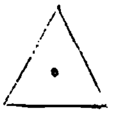


Marsh or Swamp

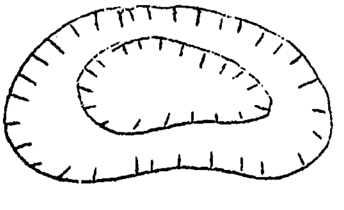
Buildings



Bridge



Benchmark
(Indicate where an elevation and locatior. is known)



Depression contour

TEACHER DIRECTION

E - 64

TOPOGRAPHIC MAPPING

Materials for groups of three:

1. Plastic box
2. Mountain model
3. Food coloring or ink
4. Grease pencil
5. Transparent sheet

This activity is to help the students understand topographic maps and the terms used.

Have the students make a series of marks 1.5 cm apart up the side of the box. The spaces between the marks are contour intervals. Then have each group of students place the mountain model inside the box and fill the box with water to the first mark. With the grease pencil they should draw a line around the model mountain at the water line. A few drops of food coloring in the water will make it easier to see the lines. Students should repeat this procedure for each level until the model mountain is covered. When they have finished the contouring, have them put the lid with the clear plastic sheet taped to it on the box and trace the contours as they see them from above.

The contour map of the plastic volcano as the students should have drawn it is on the transparency.

STUDENT E - 64

TOPOGRAPHIC MAPPING

Materials for groups of three:

1. Plastic pan
2. Mountain model
3. Food coloring or ink
4. Grease pencil
5. Transparent sheet
6. 500 ml flask

Make a series of marks 1.5 cm apart up the side of the box. Then place the mountain model inside the box and fill the box with water in which you have added some food coloring or ink. To the first mark (you may have to tape the mountain model down or have one student hold the model down to keep the water from pushing the model up) with your grease pencil draw a line around the model mountain at the water line. Repeat this procedure for each level until the model mountain is covered. When you have filled the pan to the top mark put the lid with the clear plastic sheet taped to it on the box and trace the contours as you see them from above. If you close one eye, it is easier.

What kind of lines are represented on the plastic sheet?________________________

What is the contour interval of this map?____

Use your resource sheet for help in answering questions if needed.

TEACHER DIRECTION E - 65

TOPOGRAPHIC PROFILE

Materials for groups of three:

1. Sheet of paper
2. Ruler

Since the students have a fair knowledge of topographic maps, as seen from an aerial view we would like for them to be able to see what the topography of certain areas would look like from a cross sectional or side view. To do this the students will have to involve himself in simple graph making.

Have the student to follow the steps given on their activity sheet explaining how to construct the profiles. This will require the teachers to give some assistance to each of the groups. Before the students begin place the topographic map transparency on the overhead projector and explain what is to be done.

You may make up some simple maps for the students to practice their profiles.

STUDENT E - 65

TOPOGRAPHIC PROFILES

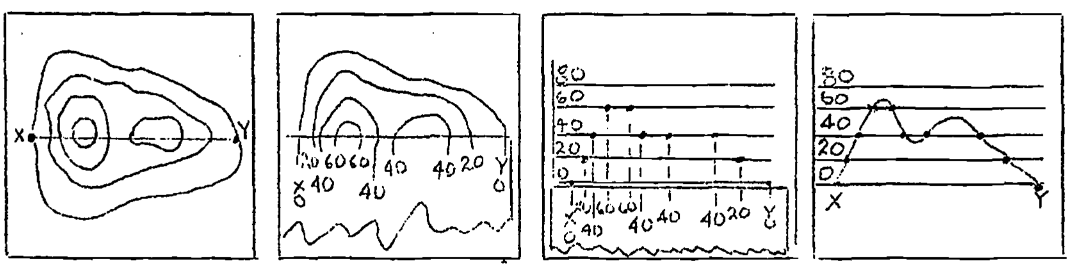
Materials for groups of three:

1. Sheet of paper 2. Ruler

In this activity you will see how topographic maps can show a side view of a certain area. As you would see it standing along side of it.

Use the following steps to construct your profile. If you need any assistance ask your teacher.

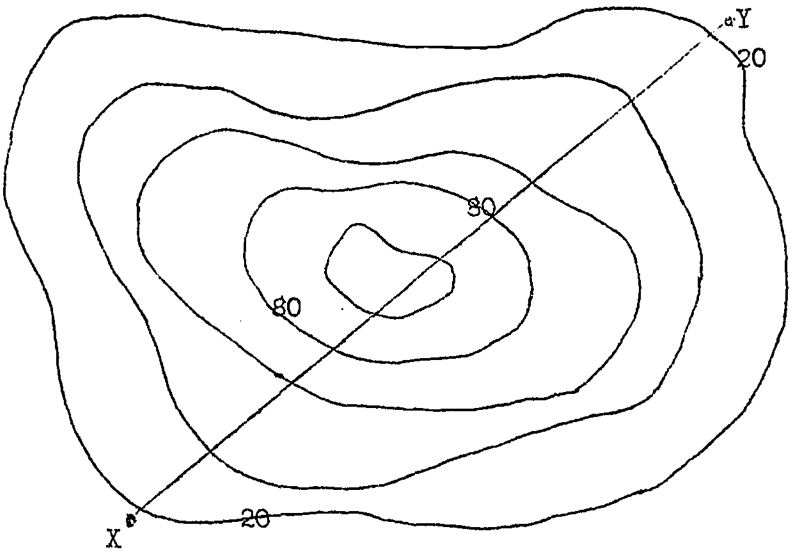
1. Draw a straight line on the map at the desired cross section. (See figure a.)
2. Place the straight edge of a sheet of paper along the bottom line. On the paper mark the position of the end points of the area and where each contour line meets the edge of the paper. Note the elevation of each contour line (see figure b)
3. Place the marked paper edge along the bottom of your graph. Show the position of each contour line by placing a dot on the proper horizontal line (see figure c).
4. Connect the dots with a smooth line (see figure d).



(a) (b) (c) (d)

Student
page 2

Let's see if you can do a profile for this map. To answer the question you may need to refer to your student resource sheet E - 69



What is the contour interval?________________________

120____

100____

80____

60____

40____

20____

0____

TEACHER DIRECTION E - 66

READING TOPOGRAPHIC MAPS

This activity is a culminating activity to allow the students to use some of their knowledge of topographic mapping to answer some questions about a particular map. Spend some time soliciting answers for questions you might ask your students in preparing for this activity.

Special procedures are sometimes required to determine direction, elevation and distance.

1. DIRECTION The map may be oriented by following meridians (north-south) or the map arrow that points to true north. When there are no indications, the top of the map is assumed to be north.

2. ELEVATION Use the given contour interval. When the interval is not given, it can be determined by dividing the elevation difference between two marked contour lines by the number of intervals between them. Ocean shorelines have sea-level elevations of 0 feet.

3. DISTANCE Mark off the required distance on the straight edge of a sheet of paper and compare with the graphic scale. Zigzag edge as a series or succession of straight paths. When the scale is given in miles per inch, distance can be read directly with a ruler.

These are the answers to the questions to be asked of the students.

a. 20 feet There are five intervals between sea level (0 feet) and the 100 foot contour line.

b. 199 feet Since the last contour line is at an elevation of 180 feet, the actual height of the hill top is at least 180 feet but not quite 200 feet.

c. East

d. About 5 miles

e. 64 square miles The map represents an area 8 miles by 8 miles.

f. A depression

STUDENT

E - 66

READING CONTOUR MAPS

Materials for each student

1. A sheet of paper
2. A ruler

Let's see how much we know about contour (topographic) maps. The following questions refer to the map below:

a. What is the contour interval?____________________

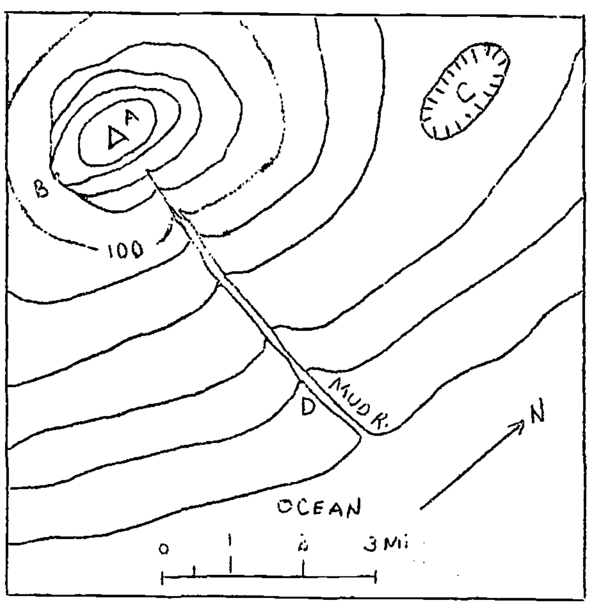
b. What is the maximum possible elevation of hill A?____________________

c. In what direction does Mud River flow?____________________

d. What is the length of Mud River?____________________

e. What is the area of this map.____________________

f. What does the symbol at (c) represent?____________________



UNIT 9

OCEANOGRAPHY

UNIT 9

OCEANOGRAPHY

Oceanography is a fast growing and needed science. To learn some of the simple investigations that are going on we are attempting to relate some of the investigations in this series of activities on a small scale.

E-67 MEASURING THE OCEAN DEPTH Film: THE OCEAN: A FIRST FILM

E-68 WATER PRESSURE AND DEPTH

*E-69 WHY IS THE OCEAN SALTY

E-70 FRESH WATER DERIVED FROM OCEAN WATER

E-71 DETERMINING % OF SALINITY OF SEAWATER BY WEIGHT

E-72 OCEAN WAVES CHANGES THE SHORELINE

E-73 THE OCEAN FLOOR

E-74 ORIGIN OF FLORIDA SHORESANDS

* Reading Activity

UNIT - 9

TEACHER RESOURCE

OCEANOGRAPHY

Oceanography - The branch of science which deals with the study of the ocean.

About 75 per cent of the earth's surface is covered with water. Because of this vast amount of water scientists are becoming more and more involved in studying its composition from all aspects. (Geological, physical, biological and Chemical) to find the answers to their questions oceanographers have developed many special methods, techniques, and instruments for their work. Much oceanographic research and collection of data takes place aboard specially equipped ships. Ships can be used to gather considerable information about the ocean, but some can only be collected far beneath the surface. To do this scientists have invented bathyspheres or bathyscaphes to go to depths of 35,000 feet. One of the most well known bathyscaphes is the triest. At relatively shallow depths scientists utilizes self-contained underwater breathing apparatus (scuba).

The scientists are finding more about the oceans than ever before and are also using much of their finds for commercial purposes such as seaweed for the processing of ice cream, jellies, jams, toothpaste, cosmetics, and ink. The chemical products found in the oceans are sodium chloride, the metal magnesium and bromine to name a few.

TEACHER DIRECTION E - 67

MEASURING THE OCEAN DEPTH

This reading activity is to orient the student to the methods used in determining the topography of the ocean. While reading over the activity with the students throw out lead questions concerning the activity, such as WHAT KIND OF SURFACE WOULD BE REVEALED IF THE OCEANS WERE DRAINED OFF? WHY WEREN'T THE ROPE AND CABLE VERY GOOD METHODS? WHY ARE WE TO TAKE HALF THE NUMBER OF SECONDS FOR THE WAVES TO BE RECEIVED?

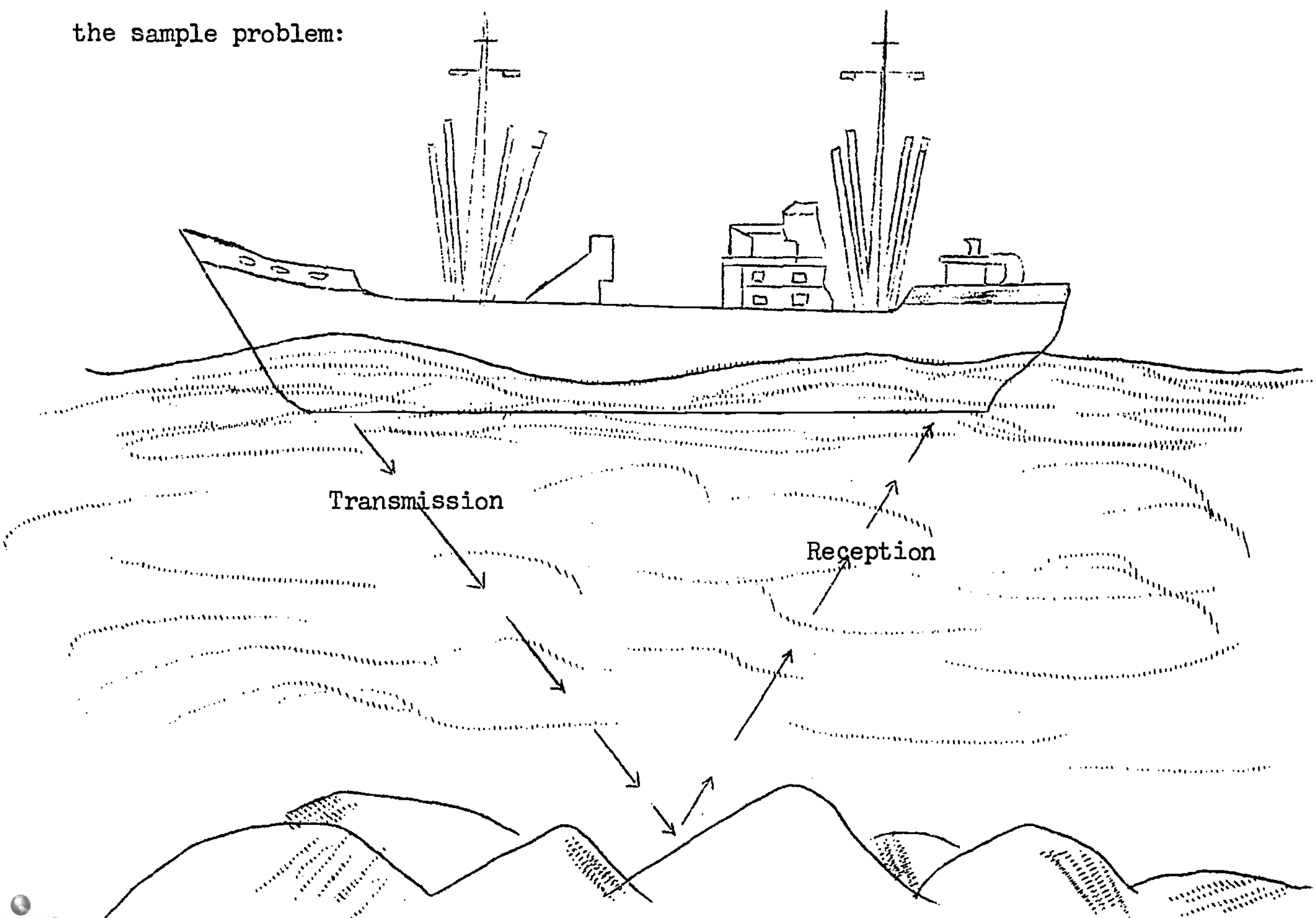
When the students understand that the ocean floor is much like the land surfaces go on to the next activity.

STUDENT

E - 67

MEASURING THE OCEAN DEPTH

If the ocean waters were drained off from the ocean basins, what kind of surface would be revealed? To answer this question, oceanographers take many soundings (measurements of the ocean depths) of the ocean waters. From these soundings, they try to draw a picture of the ocean floor. When oceanography first started soundings were made by using a rope with a heavy weight tied to one end. This was lowered into the water until the weight struck the bottom. Later methods involved using a wire cable instead of rope. Today, however, soundings are made by using sound waves which are reflected from the surface of the ocean floor. Since the speed of sound waves in water is known, the distance from the ship to the ocean floor can be easily calculated. Look at the sample problem:



Student
page 2

Sound waves travel in ocean water at a speed of about 4,800 feet per second. A wave sent out from a ship's transmitter is reflected from the ocean bottom and picked up on the ship's receiver. The time from transmission (sending) to reception (received) is five seconds. How deep is the ocean at this point?

Solution:

1. Speed of sound wave in water - 4800 feet per second
2. Time= 5 seconds for total time
   (2.5 seconds for $\frac{1}{2}$ distance)
3. 4800 x 2.5 = 12,000 feet.)

Can you determine how deep the ocean is if the time of transmission to receiving is 8 seconds? Let's try.

TEACHER DIRECTION

E - 68

WATER PRESSURE AND DEPTH

Materials for groups of three:

1. Thistle tube
2. Balloon
3. Grease pencil
4. Beaker (400 ml)
5. Rubber band
6. Food color or dye

In this activity the students should observe that the water pressure increases as we go deeper into the water. Ask them if they have ever had their ears to become stopped up or pop when they ride up or down a steep hill? Discussion. WHAT CAUSED THIS? Solicit answers but do not give the answer. Show them transparency E-68 and let them get started.

STUDENT

E - 68

WATER PRESSURE AND DEPTH

Materials for groups of three:

1. Thistle tube
2. Balloon
3. Grease pencil
4. Beaker (400 ml)
5. Rubber band
6. Food coloring or dye

Under normal conditions of life man is adapted to live at an atmospheric pressure of 14.7 pounds per square inch (psi) at sea level. We are not aware of this force because the pressure inside the body is the same as the pressure outside it. The only time a person may become aware of this pressure is when it changes rapidly, such as when we go up in the air or down in the ocean. The occasional 'popping" of the ear drums reminds us that we live in a sea of air at specific pressure.

Let's prove that depth in water increases the pressure on objects. Obtain the materials needed for your group.

Cover the wide end of a thistle tube with a piece of rubber from a balloon. Partially fill the thistle tube with water and dye, mark the level of the water in the tube, then lower the covered end into a container of water. What do you observe happening to the liquid in the narrow portion of the tube as it is lowered deeper into the water?____.

What does this show about the realtionship between water pressure and depth?______

____

TEACHER DIRECTION E - 69

WHY IS THE OCEAN SALTY

In this activity the students should get an understanding of how the ocean water became salty.

Have the students to read the activity over a couple of times to insure their comprehension, then you read it aloud while the students read silently. When you reach a question pause and solicit answers to see if the students have the correct understanding. When you feel the students have a fair understanding of how the oceans became salty go to the next activity.

TEACHER DIRECTION E - 70

FRESH WATER DERIVED FROM THE OCEAN

Materials for groups of three:

1. Distilling flask
2. Salt (NaCl) or ocean water
3. Bunsen burner
4. Graduated cylinder
5. 2 beakers (400 ml)
6. Stoppers, rubber
7. Ring & Ring stand
8. Wire gauze

We know that fresh water is becoming a problem, that is we are running out of fresh water. Their are several ways to convert ocean water to fresh water. The electrical method, where electricity is used to remove dissolved salts; the membrane method, where salt water interacts through a semiporous material which allows only the fresh water to pass through it; and others. The most common is the evaporation condensation method. The students will do this on a simple scale. Ask them; HOW MANY CAN TELL OCEAN WATER FROM FRESH WATER? Discussion. SUPPOSE WE HAD A WAY TO CHANGE THIS OCEAN WATER SO THAT WE COULD DRINK IT. LETS SEE IF WE CAN DO THAT HERE IN CLASS.

Show them transparency E-70 to see how to set up the apparatus then read aloud the students directions while they read silently. Circulate among the groups and assist the students if necessary.

STUDENT E - 70

FRESH WATER DERIVED FROM THE OCEAN

Materials for groups of three:

1. Distilling flask
2. Salt (NaCl) or ocean water
3. Bunsen burner
4. 2 beaker (400 ml)
5. Stopper, rubber
6. Ring & ring stand
7. Graduated cylinder
8. Wire gauze

In the future the ocean will become one of our most important water sources, but we know we can't take the ocean water and sit it in the refrigerator to get cold for drinking can we? First we will have to change the salty water to fresh water. Let's find out how.

Obtain the material from your teacher and set up the apparatus shown on the overhead projector. Put 300 ml of water in a beaker and add 20 ml of salt and stir it until the salt has dissolved. Taste it, is it salty?____________ Pour the dissolved salt water into the distilling flask, let it boil until you have collected about 100 ml of the water into the other beaker. Taste it, is it salty?____________________ What is happening to the water as it boils? ____________________________ After it evaporates what happens?__________ ______________ Would you drink ocean water after going through this process? ______________________ If yes, taste it.

TEACHER DIRECTION E - 71

TO DETERMINE % OF SALINITY OF SEA WATER BY WEIGHT

Materials for groups of three:

1. 500 cc of Ocean water (pint or quart jar)
2. 500 cc of lake water (city water if necessary
3. 2 small beakers (200 ml)
4. 1 set gram scales
5. Medicine dropper
6. 1 bunsen burner or alcohol burner
7. 3 pair safety glasses
8. 1 ring stand
9. Asbestos pad

Pass out student directions and read directions with students. Bring out the fact that salinity refers to the amount of salt contained in a given amount of water from a certain location; and that it is usually determined more rapidly by chemical means which will be taken up at a later date. The fact that the student is able to see the salt (residue), this fact alone is impressive and interesting to the students involved.

Weight of the beaker and water contained is of prime importance as to the end results obtained. Stress should therefore be put on care in weighing the beaker and its contents. The medicine dropper should be used to obtain even gram weights accurate to a tenth of a gram.

The student is to be directed to fill the beaker approximately $\frac{1}{2}$ full and obtain an even weight in grams using a medicine dropper. This is important because of the time involved.

The student should record the weight of his beaker; then, the weight of his beaker plus the added sea water. Have students wear safety glasses when evaporating the water.

To evaporate the water place the beaker with sea water on the ring stands over the burner flame. Liquid should be allowed to completely boil away. The asbestos pad is to be used to remove beaker with residue to the gram scales. Students are to

Teacher Direction
page 2

weigh and record weight of beaker and residue; weight accurately to a tenth of a gram. To determine the weight of the residue subtract the weight of the empty beaker from the weight of the beaker with the residue. Have students divide weight of sea water into weight of residue to determine percentage of salinity. Direct students how to carry the answer to two or three decimal places for an accurate answer.

This procedure should be repeated the following day with the lake or faucet water and results should be compared. Have students retain their recorded weights from one day to the other for comparison.

STUDENT ACTIVITY E - 71

TO DETERMINE THE % OF SALINITY OF SEA WATER BY WEIGHT

Materials for groups of three:

1. 500 cc of ocean water
2. 500 cc of lake water
3. 2 small beakers (200 ml)
4. 1 set gram scales
5. Medicine dropper
6. 1 bunsen or alcohol burner
7. 3 pair safety glasses
8. 1 ring stand
9. 1 asbestos pad

Student Information: For sanitary reasons samples should be from approved sources for the following test.

Take a drop of sea water from your medicine dropper and taste it. Is it sweet, sour or salty?__________ Rub your fingers over the wet area. Do you feel salt?___________ Blow your fingers until they are dry. Now rub your fingers over the area. Do you feel a grit or "sandy" feeling?_______________.

The salty taste and the fact that when your fingers were wet indicate that there was something dissolved in the water. When the water dried, the "grit" that is felt is salt. Now let's find out How Much Salt.

Take one empty beaker and weigh it on the gram scales. Carefully record this weight in grams and tenths of grams. If there is a question as to the weight, ask your instructor. A careful weight is very important.

Now fill your beaker ½ full of sea water. Weigh the beaker and the sea water again carefully record the weight. To calculate the weight of the sea water, subtract the weight of your beaker from the weight of your beaker ½ full of sea water. Place this weight on a clean piece of scrap paper. You will use this paper again so save it.

Put on your safety glasses and have the instructor light the burner. Place the beaker and sea water on the ring stand and put your burner in the proper position. Allow the sea water to boil away being careful not to allow it to boil over.

Student
page 2

When only a white powder remains, move your beaker and the white powder to the gram scale. Weigh this and look back to your records for the weight of the empty beaker. Subtract the weight of the empty beaker from the weight of the beaker and white powder. Record this weight which is the weight of the white powder. This figure is the weight of the salt in your beaker of sea water.

Now take the weight of the sea water on the scrap paper and divide it into the weight of your salt. You answer will be the percentage of salinity. This salinity is the amount of salt in a known amount of sea water from one place in the ocean. This salinity changes from place to place.

2nd day. Repeat the above activity using the lake water and compare your salinity percentages.

TEACHER DIRECTION E - 72

OCEAN WAVES CHANGES THE LAND SURFACE

Materials for groups of three:

1. Gas collecting bottle
2. 5 - 10 rock chips (Limestone)
3. Balance scale
4. Paper towel

Try to get the students to visualize an area on a beach where there are large boulders and the ocean waves are pounding on the boulders. WHAT DO YOU SUPPOSE IS HAPPENING TO THE BOULDERS AS THE WAVES SPLASH AGAINST THEM? Discussion. Try to get them to remember the terms weathering and erosion. With this in mind the students can see a change is taking place on the boulders. LET'S SEE IF WE CAN MAKE A CHANGE IN THE LAND SURFACE BY OCEAN WAVES. Pass out the materials and read the student page aloud while the students read silently.

A portion of the period may be devoted to learning how to read the balance.

STUDENT E - 72

OCEAN WAVES CHANGES LAND SURFACES

Materials for groups of three:

1. Gas collecting bottle
2. 5 - 10 rock chips (thin)
3. Balance scale
4. Paper towel

We read in a previous activity that the land surfaces can be changed by weathering and erosion. In this activity let's find out what effect does the ocean waves have on land surfaces.

Weigh a bottle and record its weight. Now add 5 - 10 chips (thin rock chips) to the bottle and weigh the bottle with the chips. Record the weight. Then add some water to the bottle so that it is about half full. Place your hand over the mouth of the bottle and shake vigorously for ten minutes. Poor the water out of the bottle carefully, but do not lose any chips. Now wash the chips with clean water and again pour the water out carefully. Dry the chips off with a paper towel. Place a paper towel in the bottle to remove all the water. Why?______________________________________

Now weigh the bottle and chips again. Check your results with others in the class. What conclusions can you draw from this activity? Record all of your data in the charts.

Before you shook it up

Weight of Bottle	Weight of Bottle and Chips	Weight of Chips

After you shook it up

Weight of Bottle	Weight of Bottle and Chips	Weight of Chips

TEACHER DIRECTION E - 73

THE OCEAN FLOOR

Materials for groups of three:

1. Box $1\frac{1}{2}'$ x 1' x 1'
2. Sand (To cover bottom of box to a depth of 3 inches)
3. Lead weight
4. String 2'

In this activity the students will be concerned with learning the principle features of the ocean floor. These features are the continental shelf, which is the relatively shallow area surrounding all of the continents. It usually slopes very gently away from the land. The continental slope, which begins where the gradual slope of the continental shelf end. The ocean basin is the relatively level area. And we have the deep sea floor or deeps, as they are sometimes called, which goes down steeply to a sharp incline.

Almost all of the ocean floor is covered with a layer of sediment. This sediment consists of material which has been carried into the ocean by rivers; rocks and other substances remaining from glaciers; dust and other particles from volcanoes and the land which have been transported by the wind and deposited into the ocean where they slowly sink to the bottom; and, of course, the remains of the many living things which inhabit the ocean and finally contribute to the building up of the sediment layer of the ocean floor.

To help give the students an idea of what the ocean floor is like let them do activity E-73. Try to encourage the students to shape their sand so as to show the features of the ocean floor. Walk about the room assisting if necessary to get some good results.

STUDENT

E - 73

THE OCEAN FLOOR

Materials for groups of three:

1. Box $1\frac{1}{2}$'x 1'x 1'
2. Sand (to cover bottom of box to a depth of 3 inches)
3. Lead weight
4. String 2'

The bottom of the ocean is usually divided into four different areas: 1) THE CONTINENTAL SHELF - have you ever gone to the beach and noticed as you moved further into the water the land sloped gently, this is the continental shelf which may extend for many miles. 2) THE CONTINENTAL SLOPE - it slopes from the edge of the shelf gradually into the 3) DEEPS OR TROUGHS which goes down very sharply. 4) THE OCEAN BASIN is the overall depressed portions of the earth containing waters of the oceans. The areas have a thin cover of sediments brought to the ocean from various sources.

Not only does the ocean occupy a large area of the surface of the earth, but the ocean also is, on the average quite deep. The average depth has been estimated at about $2\frac{1}{2}$ miles. In some places, the ocean is as deep as 7 miles.

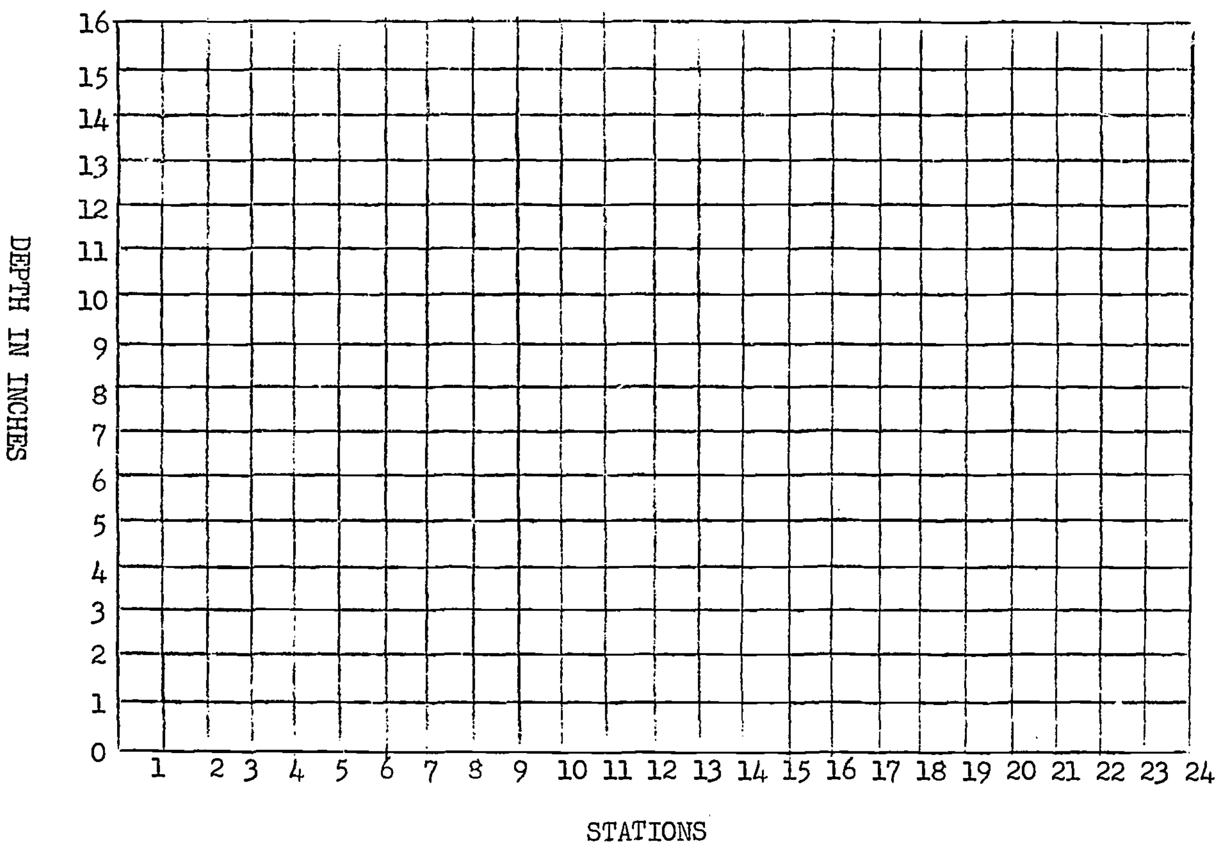
Would you like to make a model of the ocean floor? This is one way you can make a model showing the nature of the ocean floor.

Place sand in the bottom of a box to a depth of about 3 inches. Then work the sand into low and high patterns. Tie a weight to a string which is about 24 inches long. Mark the string at 1 inch intervals, beginning at the bottom of the weight.

Cut holes in the cover of the box one inch apart and number them. Drop your weight at intervals of 2 inches. Be sure the string doesn't have any slack in it. Record the depth at each station. When all the measurements are recorded, connect the points on your graph.

Are you able to recognize the different areas of the ocean floor from your profile?____________ Name the areas you see________________, ________________, ________________________, ________________________________

Student
page 2



TEACHER RESOURCE - To determine the type of material on our beaches, read and discuss the following paragraph.

All of the beaches of Florida are not made of sand. When we look at the white beaches of Panama City and Daytona Beach, of Jacksonville and Pensacola we then and there think of all of the beaches of Florida as being made of white, coarse beach sand. Not true, there are many more Florida beaches made of shell and ground coral than are made of ground quartz and sandstone. We say quartz and sandstone; yet, these rocks from which they come are not found in Florida. If this is so, then where did they come from? The white sands of Florida's beaches really came from the high mountains of Georgia, South Carolina, North Carolina or Mexico.

How did they get here? The major rivers of the southeast and of Mexico washed the worn rocks and minerals down from the mountains to the sea. Once in the sea, the currents flowing north and south along our shores wash the beach material in a never ending cycle. The cold Labrador current from the North Atlantic picks up mountain borne materials flowing from the Cooper and Edisto Rivers of South Carolina and the Savannah, Altawaha and Ogeechee of Georgia and moves this materials down along the Florida coast until Cape Canaveral diverts it out into the Gulf Stream.

The rivers flowing from high in the mountains of Yucatan and Mexico deposit their mountain materials into the Gulf and they are carried by the Yucatan current on the beaches of Northwest Florida. When this yucatan current slows and swirls near Panama City, this material either sinks into the Gulf or is deposited on the beaches.

While these currents make these beaches white with the mountain minerals, an entirely different process is taking place on the remaining beaches of Florida.

Teacher Resource
page 2

Panot fish feed on the coral reefs of the Keys and pass off a powdery waste of fine organic coral. The mollusks die and their shells are ground up by wave action. Waves pound on the exposed limerock of ancient sea bottoms. Through this action a finely ground mass of organic material is moved into the Gulf Stream passing through the Florida Keys. This "sand" made of dead sea animals is moved up the East and West coasts of Florida and cast upon the beaches until Cape Canaveral on the East and a weakening Gulf Stream current on the West stops the shell deposit. Thus, our beaches are really very different in the Northern and Southern parts of our State.

We have several tests to determine if our beaches are really made of "sand" or "shell".

Most beach materials are ground to such a fine state that it is difficult to really tell their origin by just looking at them.

TEACHER DIRECTION E - 74

CRIGIN OF FLCRIDA SHORE SANDS

Materials for groups of three:

1. 1 petri dish or large jar lid
2. 1 baby food jar of beach sand from Jacksonville beach (sand from near the low tide mark)
3. 1 baby food jars of Builders Sand (Control)
5. Medicine bottle with dropper filled with 10% HCl
6. 1 small piece of window glass (about 3" x 3")
7. 1 magnifying glass

Pass out materials to students only after a full class period of reading the material listed and discussing the reasons and explanation of ocean currents and their function in moving beach materials.

The control sand should be tested first.

Student should use his magnifying glass to view the sand and observe the cleavage of the substance and look closely for any sea shell particles. The control sand is almost pure particles of quartz; thus, he will not find many particles or organic matter. The next step is to place his plate glass flat on the desk and pour a small amount of control sand on one corner of the plate. Have him rub the sand in a circular motion being careful to restrict his rubbing to only that corner area. Instruct the class to brush the sand away and observe the glass for scratches. The plate will be scratched since quartz is harder than glass.

The students then should pour a thin layer of the control sand over the bottom of the petri dish. Have him add a medicine dropper of 10% dilute HCl over the sand. There will be little or no reaction. Explain at this point that HCI does not react with quartz or most inorganic materials. The test on the control should prove that the material is inorganic and thereby, from mountain regions rather than the organic limestone of Florida.

Teacher Direction
page 2

The second test is to repeat the above tests on the beach sand # 2. A visual observation will show particles of shell. A scratch test will not scratch the glass other than at random points since shells are softer than glass.

The HCl test will react violently; thus, proving that the major portion of the material is organic.

The testing should go on to sample # 3, Jacksonville Beach sand.

The visual observation will show some shell material. The scratch test will mark the plate well. The acid test will not be violent but there will be a mild reaction on the few shell particles present.

STUDENT E - 74

ORIGIN OF FLORIDA SHORE SAND

Materials for groups of three:

1. 1 petri dish or large jar lid
2. 1 baby food jar of beach sand from Jax. beach (sand from near the low tide mark)
3. 1 baby food jar of coarse sand (control)
4. 1 baby food jar of "sand" (shell) from Nubler's pier. (Take sand from dune area above high tide mark)
5. Medicine dropper and bottle filled with 10% HCl
6. 1 small piece of window glass (3" x 3")
7. 1 magnifying glass

Obtain the materials from your teacher. Label your jars # 1 control sand, #2 Nubler's pier sand #3 Jacksonville Beach sand. The control sand should be tested first.

Use your magnifying glass to view the sand and observe the cleavage of the substance and look closely for any sea shell particles. Do you see any shell particles_____________. Next place your plate glass flat on the desk and pour a small amount of control sand on one corner of the plate and rub the sand in a circular motion. Being careful to restrict his rubbing to only that corner area. Now brush the sand away and observe the glass for scratches. Are there any scratches__________________.

Pour a thin layer of the control sand over the bottom of the petri dish and add a medicine dropper of 10% dilute HCl (Hydrochloric acid) to the sand. What happened?____

The second test is to repeat the above tests on the Nubuler's pier sand. Do you see any shell particles?__________________ Are there any scratches on the corner of the glass?______________ What happened when you put the HCI on the sand_______________________.

Student
page 2

Repeat the procedure for the Jacksonville beach sand. Are there any shells?
________________________ Do you see any scratches _______________ Did the HCl cause the sand to bubble__________________________.

From these test would you say our sands on the shores of our beaches are the same?___________________________

DISCUS

Materials for Class of 30 in Groups of Three
Earth Science

ITEM	QUANTITY
Supplies	
Baby Food Jars	90
Balloons, vertical	30
Balls, styrofoam (6" and 3") each	30
Contour model with plastic box	30
Flashlight	10
Glue, bars	10
Hand lenses	30
Maps (city and U.S.), each	10
Petroleum jelly, cans	5
Plaster of Paris, lbs.	20
Sea Shells (small)	30
Sea Water, pts.	30
Wire, thin, feet	50
Wooden,ruler	10
GLASSWARE	
Distilling flask	10
Thistle tube	10

ITEM	QUANTITY
CHEMICALS	
Alum crystals, pound	5
Copper chloride, pound	1
Copper sulfate, pound	5
Iron chloride, pound	1
Nickle sulfate, pound	5
Potassium nitrate, pound	1
Rochelle salt, pound	5
Sodium silicate, pint	1
ROCKS AND MINERALS	
Andesite porphyry, each	14
Amphibole hornblende, each	14
Asbestos (serpentine), each	14
Basalt, each	14
Biotite gneiss, each	14
Calcite, each	14
Chalcopyrite, each	14
Chert or flint, each	14
Cinnabar, each	14
Gabbro, each	14
Garnet mica schist, each	14
Halite, each	14

ITEM	QUANTITY
Rocks and Minerals con't	
Jasper conglomerate, each	14
Kame conglomerate, each	14
Limestone, each	14
Limestone chips, each	14
Marble, each	14
Mica, each	14
Mica schist, each	14
Mohs' hardness scales, boxes	10
Pumice, each	14
Pyroxene, each	14
Quartz, uneven, each	14
Quartzite, each	14
Rhyolite, each	14
Sand stone, each	14
Shale, each	14
Slate, each	14
Staurolite, each	14
Talc, each	14
Tremolite, each	14